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NOTE follow	E: The Preserve Description report is very similar to previous iterations and changes are as s:
•	Narrative regarding golden-cheeked warbler habitat in Hidden Springs Ranch was updated in Section 2.16.2 that reflects the updated habitat delineation resulting from the 2021 and
	2022 nesting surveys. The golden-cheeked warbler appears to utilize significantly more habitat than assumed during the 2019 habitat delineation.

# PRESERVE DESCRIPTIONS OF LAND MANAGED BY THE WILLIAMSON COUNTY CONSERVATION FOUNDATION UNDER THE WILLIAMSON COUNTY REGIONAL HABITAT CONSERVATION PLAN

Prepared for

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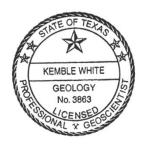
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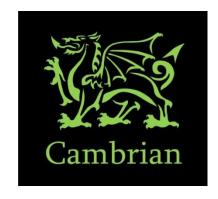
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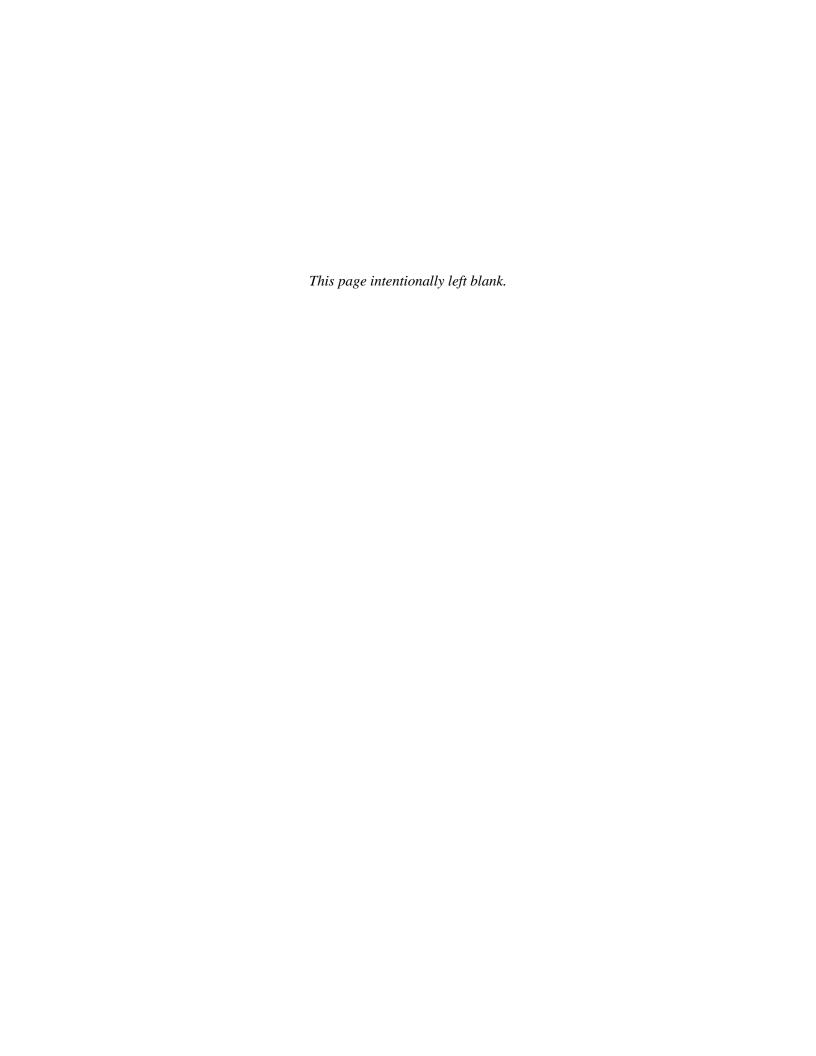
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# PRESERVE SUMMARY

The 15 karst feature preserves currently administered by the Williamson County Conservation Foundation (WCCF) range in size from approximately 1 acre up to 172.2 acres and contain a wide variety of explored and unexplored karst habitat features. Table PS1 shows the number of karst features contained within each preserve, as well as any karst fauna area (KFA) status acreage. The WCCF oversees the management of more than 50 named karst features within approximately 943.1 preserve acres, 530.1 acres of which are designated KFAs. The WCCF acquired the Hidden Springs Ranch in 2020 as a golden-cheeked warbler (*Setophaga chrysoparia*) preserve, which occupies approximately 932.5 acres and has no known caves.

Table PS1. Williamson County RHCP Preserve Resources

Preserve Name	Year Preserve Established	Number of Named Karst Features	Approximate Preserve Acreage	Approximate KFA Acreage	Listed Karst Invertebrates Found In Preserve
Twin Springs KFA	2009	2	172.2	172.2	Texella reyesi, Batrisodes texanus*
Beck Preserve	2009	7	44.5	0	Texella reyesi
Cobbs Cavern KFA*	2009	1	163.0	163.0	Texella reyesi, Batrisodes texanus
Millennium Preserve	2012	6	74.4	0	Texella reyesi
Wilco Preserve	2012	13	152.5	0	Texella reyesi
Chaos Cave Preserve*	2012	4	30.0	0	Texella reyesi
Big Oak Preserve*	2013	1	10.0	0	Rhadine persephone
Priscilla's Well KFA	2011	2	51.5	51.5	Texella reyesi, Batrisodes cryptotexanus
Woodland Park Cave Preserve	2012	2	10.2	0	Texella reyesi, Batrisodes cryptotexanus
Karankawa Cave KFA	2013	8	61.7	61.7	Texella reyesi, Batrisodes cryptotexanus
Coffin Cave Preserve	2014	1	39.4	0	Texella reyesi, Batrisodes texanus
Beck Commons Preserve	2014	2	4.2	0	Texella reyesi
Shaman Cave KFA	2016	8	81.7	81.7	Texella reyesi, Batrisodes cryptotexanus
Bat Well Cave Preserve	2017	1	46.5	0	None
Snowmelt Cave Preserve	2019	1	1.3	0	Texella reyesi
Hidden Springs Ranch	2020	0	932.5	0	None
Total		59	1,875.6	530.1	

<sup>\*</sup> Easement, not owned by Williamson County

Section 9.3.2 of the Williamson County Regional Habitat Conservation Plan (RHCP) (SWCA Environmental Consultants [SWCA] et al. 2008) indicates that by 2025, WCCF shall acquire 700 karst preserve acres through direct purchase or acquisition of perpetual conservation easements. RHCP Section 9.3.2 (SWCA et al. 2008) also indicates Williamson County planned to purchase 500 karst preserve acres outright and acquire 200 karst easement acres from private landowners. The WCCF currently administers approximately 943.1 karst preserve/easement acres and has, thus, exceeded the karst preserve acreage predicted for this point in time in the RHCP (SWCA et al. 2008). Table PS2 shows predicted karst

preserve acreage at the time the RHCP was written, versus the current karst preserve acreage administered by the WCCF.

Table PS2. Current Preserve Acreage Versus Expected Cave Acreage as Determined by the Williamson County Regional Habitat Conservation Plan

Preserve	Minimum Cave Preserve Acreage Required by 2025	Current Preserve Holdings (2020)
Williamson County Owned	500	740.1
Conservation Easement	200	203.0
Total	700	943.1

The RHCP (SWCA et al. 2008) prescribes that the WCCF shall establish and administer nine to fifteen 40- to 90-acre KFAs to enhance efforts toward listed karst invertebrate recovery; three of the KFAs are to be distributed within the three Williamson County KFRs (North Williamson County, Georgetown, McNeil/Round Rock) covered by the RHCP. The WCCF administers five (one is pending final approval by U.S. Fish and Wildlife Service [USFWS]) KFAs in the North Williamson County KFR for three karst invertebrates (*Texella reyesi*, *Batrisodes texanus*, *B. cryptotexanus*) as of 2021 and two KFAs (pending final approval by USFWS) are in the Georgetown KFR for *T. reyesi*. All covered KFRs still contain available, undeveloped land with potential to create additional KFAs, including the Round Rock/McNeil KFR. Table PS3 lists current KFAs and their associated endangered karst invertebrates.

Table PS3. Established and Pending Karst Fauna Areas and Documented Endangered Karst Invertebrate Presence

KFA	KFR	Texella reyesi	Batrisodes texanus	Batrisodes cryptotexanus
Twin Springs	North Williamson County	$\checkmark$	$\sqrt{}$	
Cobbs Cavern	North Williamson County	√	√	
Priscilla's Well	North Williamson County	√		√
Karankawa Cave	North Williamson County	√		√
Shaman Cave (pending)	North Williamson County	√		√
Millennium (pending)	Georgetown	√		
Wilco (pending)	Georgetown	√		

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Preserve Descriptions of Land Maintained by the Williamson County Conservation Foundation under the Williamson County Regional Habitat Conservation Plan
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### 1 INTRODUCTION

Williamson County (the County) and the Williamson County Conservation Foundation (WCCF) were issued an incidental take permit by the U.S. Fish and Wildlife Service (USFWS) in October 2008 to authorize take of four endangered species arising from a variety of covered land development activities in properties voluntarily enrolled within the Williamson County Regional Habitat Conservation Plan (RHCP) (SWCA Environmental Consultants [SWCA] et al. 2008). The RHCP was prepared by the County with funding and technical assistance from the USFWS. The RHCP supports an incidental take permit that authorizes the take of the Bone Cave harvestman (Texella reyesi), the Inner Space Caverns mold beetle (Batrisodes texanus<sup>1</sup>), the golden-cheeked warbler (Setophaga chrysoparia; GCWA), and the black-capped vireo (Vireo atricapilla; BCVI); collectively defined as the Covered Species. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct" (16 United States Code 1532[19]). Authorized take of the Covered Species is mitigated primarily through the establishment and management of preserves providing habitat for the above-mentioned Covered Species plus a suite of other species occurring in the same habitat. The WCCF preserve system (Figure 1) is intended to sustain high-quality habitat for species already on the endangered species list and to proactively conserve habitat to preclude the need to list other species. These other species include, but are not limited to, 20 troglobitic cave invertebrates and four species of spring-adapted Eurycea salamanders. Covered and additional species addressed in the RHCP are discussed in the management plan for the preserves (Van Kampen-Lewis and White 2022). Sites documented herein are categorized either as preserves or as Karst Fauna Areas (KFAs), a categorization determined by criteria set forth by the USFWS (see RHCP Section 5.3.1.1 [SWCA et al. 2008] for further details). This document describes the preserve sites, their associated caves, and any habitat therein dedicated to birds and/or salamanders listed by the USFWS as threatened or endangered.

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<sup>&</sup>lt;sup>1</sup> Chandler and Reddell (2001) split the listed *Batrisodes texanus* into two species, *B. texanus* and *B. cryptotexanus*, but the USFWS (2018a) does not recognize the split. For this reason, both species are considered federally endangered and are protected under the Endangered Species Act. USFWS (2018) indicates both species are known from a total of 25 caves.

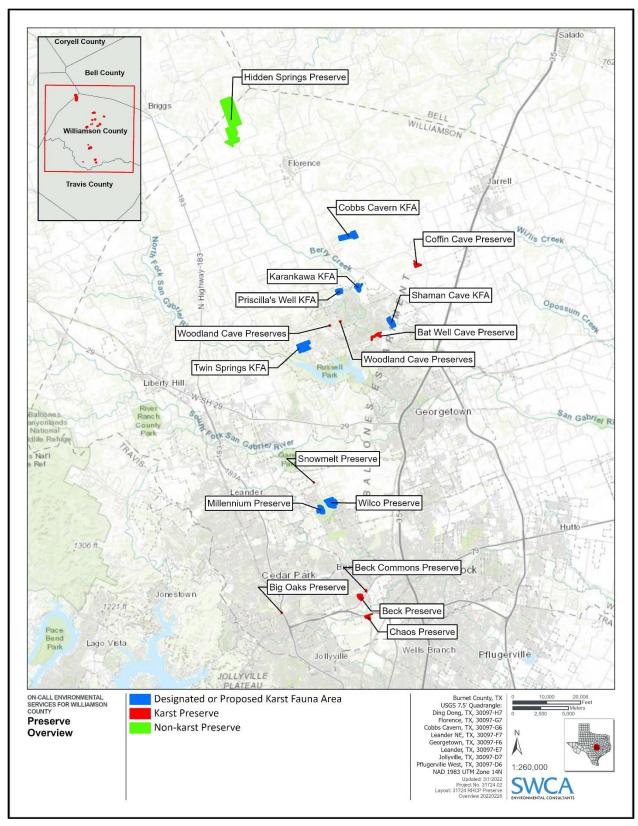


Figure 1. Williamson County Conservation Foundation preserve system map.

# 1.1 Karst Ecosystem Delineations

# 1.1.1 Karst Zones and Karst Fauna Regions

The USFWS commissioned a study in 1991 that attempted to determine the likelihood of various geological units in Williamson and Travis Counties to contain karst features with potential habitat for cave-dwelling invertebrates after listing several karst invertebrate species as endangered in 1988 (Veni and Associates 1992). These karst zones (Zones 1–4) were subsequently updated by Veni and Martinez (2007). In 2021, Veni and Jones (2021) further defined these Zones by subdividing Zone 3 and Zone 4 into two subgroups each (i.e., Zone 3a and Zone 3b; Zone 4a and Zone 4b). These studies resulted in zone delineation based on lithology, cave distribution, cave fauna distribution, and geologic controls on cave development. The zones are delineated as follows:

- Karst Zone 1: areas known to contain endangered cave fauna.
- **Karst Zone 2**: areas having a high probability of suitable habitat for endangered or other endemic invertebrate cave fauna.
- **Karst Zone 3**: areas that probably do not contain endangered cave fauna.
  - Karst Zone 3a: areas suitable for troglobite species but which have a low probability of
    containing endangered karst species because the habitat is occupied by other troglobite
    species.
  - o *Karst Zone 3b*: areas which have a low probability of containing endangered karst species because they are poorly suited for troglobite species.
- Karst Zone 4: areas which do not contain endangered cave fauna.
  - o *Karst Zone 4a*: areas suitable for troglobite species but which do not contain endangered karst species because the habitat is occupied by other troglobite species.
  - o Karst Zone 4b: areas which do not contain troglobite species.

The difference between Zones 1 and 2 is most likely an artifact of limited sampling. Zones 1 and 2 together reflect the potential distribution of cavernous rock exposed at the surface that may harbor karst invertebrates.

The study also discussed the overall karst geography of the Austin region, potential geologic and geographic barriers to karst invertebrate dispersal, and limits of species distribution. Veni and Associates (1992) originally proposed 10 karst geologic areas for Travis and Williamson Counties. USFWS (1994a) later modified the karst geologic areas into eight karst fauna regions (KFR) that serve as de facto recovery units for listed karst invertebrates: South Travis County, Rollingwood, Central Austin, and Jollyville in Travis County; and McNeil/Round Rock, Cedar Park, Georgetown, and North Williamson County in Williamson County.

Each delineated KFR was thought to be bound by geological and hydrological barriers to troglobitic species distribution as the concept was originally presented. However, subsequent studies have shown that the boundaries proposed for the KFRs do not correspond to the known species' boundaries (Cokendolpher 2004; Elliott 2004; Paquin and Hedin 2004, 2005; White et al. 2001). In addition, some species previously thought to be restricted to one KFR have been collected over several contiguous KFRs (see Paquin and Hedin 2004 for *Cicurina madla*; Ubick and Briggs 1992 for *T. reyesi*).

Veni and Jones (2021) also made changes to the KFRs in Williamson County. They extended the North Williamson County north, into Bell County, and extended the Georgetown KFR north, by reducing the southern extent of North Williamson County KFR. They also divided Cedar Park KFR into two separate

units (east and west); however, this area is not covered by the RHCP for karst invertebrates, so the new delineation is of little consequence.

# 1.1.2 Karst Fauna Area Concept

The KFA concept was first proposed in the *Recovery Plan for Endangered Karst Invertebrates in Travis and Williamson Counties, Texas* (USFWS 1994a). KFAs were envisioned as a unit of occupied habitat protected for the benefit of listed troglobitic species recovery. According to the Recovery Plan (USFWS 1994a), a KFA is described as:

...an area known to support one or more locations of a listed species and is distinct in that it acts as a system that is separated from other karst fauna areas by geologic and hydrologic features and/or processes that create barriers to the movement of water, contaminants, and troglobitic fauna (USFWS 1994a:76).

To be considered "protected", a karst fauna area should contain a large enough expanse of contiguous karst and surface area to maintain the integrity of the karst ecosystem on which each species depends. The size and configuration of each karst fauna area should be adequate to maintain moist, humid conditions, air flow, and stable temperatures in the air-filled voids; maintain an adequate nutrient supply; prevent contamination of surface and groundwater entering the ecosystem; prevent or control the invasion of exotic species, such as red imported fire ants; and allow for movement of the karst fauna and nutrients through the interstitial spaces between karst features (USFWS 1994a:82).

Although the Recovery Plan (USFWS 1994a) indicates that three KFAs should be set aside for perpetual protection within each KFR for each listed species, it provides only the following general guidelines for determining what conditions constitute a KFA:

Karst fauna areas should be far enough apart so that if a catastrophic event (for example, contamination of the water supply, flooding, disease) were to destroy one of the areas and/or the species in it, that event would not likely destroy any other area occupied by that species. (USFWS 1994a:76)

Other factors to consider when selecting KFAs include:

...the ability to ensure long-term protection, current level of habitat disturbance, past and present land use, presence of other rare or candidate species, ease of protection (landowner cooperation), and, where applicable, importance to the regional groundwater system. (USFWS 1994a:80).

...the pattern and direction of groundwater movement, direction and area of surface and subsurface drainage, preservation of the surface community above and surrounding the cave, and the presence of other caves or karst features. In general, land bounded by the contour interval at the cave floor is the area within which contaminants moving over the surface or though karst could move toward the cave. Outside this contour, contaminants would move away from the cave. (USFWS 1994a:82).

No specific criteria were provided in the Recovery Plan (USFWS 1994a) beyond these general guidelines. However, the RHCP (SWCA et al. 2008) indicates that minimum size for KFAs will be 40 acres where possible in order to protect the natural surface vegetation around a cave or cave cluster needed to support the cave ecosystem over the long term.

# 2 PRESERVE DESCRIPTIONS

# 2.1 Twin Springs Karst Fauna Area

### 2.1.1 Introduction

The Twin Springs KFA (Table 1) includes 172.2 acres located adjacent to U.S. Army Corps of Engineers (USACE) land on the north side of Lake Georgetown, west of Russell Park Road and south of the end of Twin Springs Road (Figure 2). It comprises three contiguous management areas acquired by the County between 2007 and 2009. The 12.2-acre Sunless City Cave Preserve was transferred to the County by the Texas Department of Transportation (TxDOT) in 2007 as a mitigation parcel established for the State Highway (SH) 45 project. The County acquired the adjacent 145 acres in 2008 that were not developed under the terms of the Russell Park Estates Environmental Assessment (EA)/Habitat Conservation Plan (HCP). The County also acquired management responsibility for an additional 15 acres of deed-restricted open space within the Russell Park Estates development through a 2009 agreement established between the County and the Russell Park Neighborhood Association. These three adjacent areas are managed collectively as the 172.2-acre Twin Springs KFA: with no management differences between the three tracts. Access points include gates adjacent to County Road (CR) 262 and at the cul-de-sac at the end of Twin Springs Road. The Twin Springs KFA is also a GCWA preserve and is known occupied by multiple territories during the breeding season.

The Twin Springs KFA is completely fenced and maintains appropriate signage to aid in trespassing prevention. However, the fence abutting the USACE land to the south of Twin Springs KFA is not in good shape; though trespassing from this location is unlikely to occur due to the remote nature of the neighboring tract. Few fence gaps currently exist on the southern property line; however, a planned development along this area has prompted that these gaps be fixed.

A Leave No Trace (LNT) awareness course with specific adaptations for Williamson County preserves is taught for those who wish to access the Twin Springs KFA. This 2-hour-long course provides the site-specific plan for the Twin Springs KFA and an overview of the LNT program. Attendees are provided a permit to Twin Springs KFA (and other Williamson County preserves) after completing the LNT coursework. The permit must be worn at all times while inside the KFA and human impacts are currently being monitored. The Twins Springs KFA is not closed during GCWA breeding season. The agreement between the WCCF and USFWS to designate Twin Springs as a KFA did not include language that would have prevented the public from utilizing trails for part of the year. No detectible impact to the Twin Springs KFA has been documented from visitor use.

Table 1. Basic Information for the Twin Springs KFA

Twin Springs KFA Information	
Preserve Inception Year	Acquired parcels between 2007-2009
Acreage	172.2
Fence Status	Fully fenced, with repairs needed between U.S. Army Corps of Engineers land
Sign Status	Signs posted around perimeter, warning signs on all cave gates
Baseline Vegetation Survey Date	2013
Owner	Williamson County
Gated Caves	Sunless City, Whitney West
Non-gated Caves	None

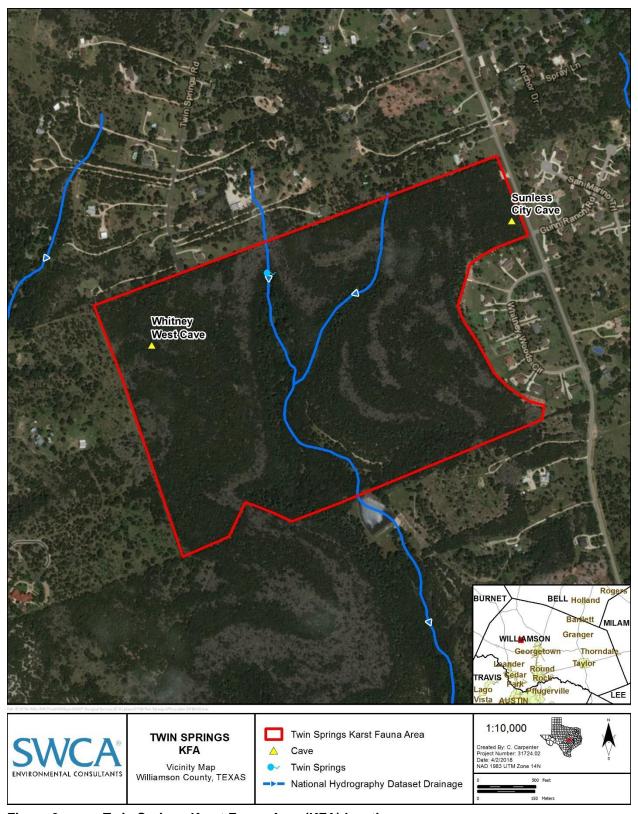


Figure 2. Twin Springs Karst Fauna Area (KFA) location map.

# 2.1.2 Hydrogeology

The Twin Springs KFA topography slopes from uplands in the northeast and northwest toward the south-central portion of the property to Taylor Ray Hollow, which drains to Lake Georgetown. Total relief on the Twin Springs KFA is approximately 140 feet, ranging from approximately 990 to 850 feet above mean sea level (amsl) (Figure 3). The Edwards Limestone is approximately 110 feet thick in the area of Twin Springs KFA. Local geology is almost entirely underlain by the Edwards limestone with the exception of the spring run and the lowest elevations along the southern preserve boundary, where the less-permeable Comanche Peak formation is exposed. The contact between these units, found generally at 880 feet amsl, provides a discharge point for the Edwards Aquifer known as Twin Springs (see Figure 3). However, recharge features on the property probably do not contribute water to the main body of the Edwards Aquifer because the hydraulic gradient between the uplands and the canyon bottom is far greater than that between the uplands and the base of the aquifer. Accordingly, recharging waters are more likely to discharge through seeps and springs near the contact between the Edwards and Comanche Peak formations (Jones 2003) as evidenced by discharge features within Twin Springs KFA.

The permanently flowing spring located in the western branch of Taylor Ray Hollow provides excellent habitat for the Georgetown salamander. Although discharge is variable, the spring has not been known to go dry, even in the 2008 and 2009 record-breaking drought. This indicates substantial interconnectivity with the main body of the Edwards Aquifer and a relatively large springshed area extending well beyond Twin Springs KFA boundaries. Based on the geomorphology of the local portion of the San Gabriel River drainage basin and the known locations of other springs in adjacent tributaries, the springshed may extend more than a mile to the northeast to Ranch-to-Market Road (RM) 2338, where the Georgetown limestone covers Edwards limestone along the drainage divide between the North Fork San Gabriel River and Berry Creek. Development in this area consists primarily of single-family homes on 2- to 5-acre lots. The relatively low impervious cover associated with this development style may have contributed to maintaining spring flow quality and quantity.

Groundwater conduits within the drainage network tend to develop greater degrees of connectivity and transport efficiency in response to the hydraulic gradient between the land surface and the base level as a karst system matures. Base level is roughly equivalent to the water table in porous media aquifers. Conduits in the vadose zone (above the saturated zone) tend to develop increasingly vertical morphologies as this occurs in response to the steep-to-vertical hydraulic gradient between the land surface and the base level. Conduits reaching base level tend to follow horizontal flow paths along the relatively shallow, commonly nearly flat, hydraulic gradient between the base level and the resurgence through which groundwater discharges at the surface. As Sunless City Cave and Whitney West Cave are part of a relatively mature karst system, it is likely that recharging waters travel along predominantly vertical pathways until encountering horizontal flow paths at the Edwards/Comanche Peak contact where they are routed toward springs above the North Fork San Gabriel River. Accordingly, recharge entering the caves likely originates primarily from strata directly above the cave footprint and secondarily through lateral seepage from a relatively restricted perimeter around the footprint. It appears, therefore, that events occurring outside of the KFA pose relatively little contamination risk for KFA caves.

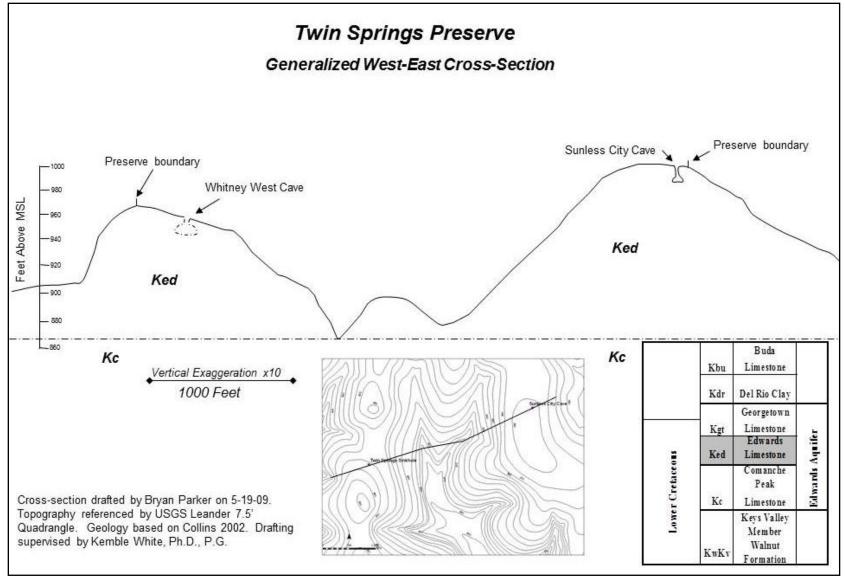


Figure 3. Twin Springs KFA geologic cross section.

# 2.1.3 Caves of the Twin Springs KFA

Cave maps are included within Appendix A.

The Twin Springs KFA contains high-quality habitat for GCWA, Georgetown salamander (*Eurycea naufragia*), and two listed karst invertebrates. Twin Springs KFA value is additionally enhanced by adjacency to undeveloped habitat around Lake Georgetown. The USACE manages the natural resources around Lake Georgetown in cooperation with Texas Parks and Wildlife Department (TPWD), the USFWS, and the Texas Forest Service. Two known caves (Whitney West and Sunless City) and several unexcavated karst features occur within the Twin Springs KFA. At least eight troglobitic species occur within the KFA including two federally endangered species: the Bone Cave harvestman and the Inner Space Caverns mold beetle (Table 2). Both caves are confirmed locations for the Bone Cave harvestman and *B. texanus* has been confirmed from Sunless City Cave and likely occurs in both caves. The WCCF assumes that Twin Springs KFA will be recognized as contributing to *Batrisodes texanus* long-term recovery if that species is detected within Whitney West Cave.

Sunless City Cave: Sunless City Cave was discovered during the planning process for the existing development along Whitney Woods Circle at the eastern preserve boundary. During excavation at the base of a nearly perfectly circular solution sinkhole, a vertical shaft was discovered dropping approximately 20 feet into a single open chamber (Photograph 1). Sparkling white speleothems on the opposite side of the main room from the entrance shaft had the appearance of a nighttime city skyline and inspired the name Sunless City (a play on words referencing the nearby Sun City Development). The stratigraphic location of the cave at the base of the Edwards Aquifer and the general morphology of the cave, including phreatic pressure doming preserved in the ceiling, indicate that Sunless City Cave was formed under phreatic conditions (below the water table) prior to the draining of the local portion of the northern segment of the Edwards Aquifer by the down-cutting of the San Gabriel River. Slowly circulating ground water gradually dissolved and removed relatively soluble limestone in the strata in which the cave is formed, creating void space. This most likely occurred preferentially along rock joints and other fractures which are currently visible in the cave walls and ceilings. As the water table dropped due to stream incision and general denudation of the land surface, Sunless City Cave became perched above the water table in the vadose zone. Subsequent collapse and modification by vertically infiltrating vadose waters have contributed to the current morphology of the cave and largely obscured additional clues as to the genesis of the cave. The current high and dry nature of caves within Twin Springs KFA is what causes them to be high-quality habitat for a diverse community of air-breathing terrestrial karst invertebrates. This cave is known to contain the Bone Cave harvestman and the Inner Space Caverns mold beetle. A cave gate currently prevents unauthorized access to this feature.



Photograph 1. Entrance to Sunless City Cave shortly after discovery.

Whitney West Cave: Whitney West Cave was discovered after a lengthy and difficult excavation guided by geophysical survey in the summer of 2008. A 25-foot-wide, but relatively shallow, collapsed sinkhole ringed by large plateau live oaks (*Quercus fusiformis*) indicated the presence of sub-surface void space, but the size of breakdown slabs within the sinkhole interior and the lack of an obvious drain left little clue as to which direction to focus excavation efforts. An electrical resistivity survey of the sinkhole indicated that void space was present and that the southern rim of the sink was most proximal to the void. Investigators discovered a fracture-controlled conduit that consistently blew cool air following approximately one month of excavation through dense fractured limestone, thick root mats, and soil. That conduit was widened into a crawlspace large enough to conduct a biological survey. After repeated efforts, the Bone Cave harvestman was discovered along with several other troglobitic species. The conduit still blows air from the great cave system at the far end of the crawl space. The crawlspace appears to be located above and adjacent to a much larger void space of unknown dimensions according to the geophysical survey profile. It is presumed that Whitney West Cave will be as biologically diverse as Sunless City Cave if it is decided to continue excavation efforts in order to allow access to the main cavern for biological surveys. A cave gate currently prevents unauthorized access to Whitney West Cave.

Table 2 shows documented species within the Twin Springs KFA.

Table 2. Species Documented from the Twin Springs KFA

	Species	Sunless City Cave	Whitney West Cave
	Permitted Species		
Texella reyesi		V	√
Batrisodes texal	nus	√	
	Other Species	·	•
	Ceuthophilus cunicularis	√	√
Crickets	Ceuthophilus secretus	√	√
	Ceuthophilus sp. B	√	V
	Cicurina varians	√	V
	Cicurina vibora	√	<b>√</b>
	Tayshaneta sp.		<b>√</b>
Arachnids	Achaearanea sp.		<b>√</b>
	Eidmannella sp.	V	√
	Leiobunum townsendi	√	<b>√</b>
	Pseudouroctonus reddelli	√	<b>√</b>
	Speodesmus bicornourus	√	<b>V</b>
	Cambala speobia	√	
Millipedes/ Centipedes	Scolopendra sp.	√	
Centipedes	Lithobiomorpha	√	
	Scutigeridae (House Centipede)	√	
	Rhadine subterranea	√	
Beetles	Staphylinidae	√	
	Coleoptera		<b>√</b>
	Eleutherodactylus marnockii	V	<b>√</b>
Reptiles/ Amphibians	Gastrophryne olivacea	V	
Ampinbians	Incilius nebulifer	√	
	Procyon lotor		√
Mammals	Perimyotis subflavus	V	
	Myotis velifer	√	
	Arenivaga noctivaga	V	V
	Surface Isopod		<b>√</b>
	Surface caterpillar	√	
	Texoreddellia texensis	V	
	Collembola sp.	√	√
Other	Helicodiscus sp.	√	
	Assassin Bug		√
	Fly	√	
	Mosquito		√
	Gnat	√	√
	Annelid	√	

### 2.2 Beck Preserve

### 2.2.1 Introduction

The Beck Preserve (Table 3) is approximately 44.5 acres purchased by the WCCF with funds from an Endangered Species Act (ESA) Section 6 grant provided by the USFWS and administered by the TPWD. It is located in the City of Round Rock, southwest from RM 620 and Great Oaks Drive intersection (Figure 4). Beck Preserve is bounded to the west and south by Cedar Valley Middle School, to the north by Great Oaks Drive, and to the east by RM 620. The site includes seven caves and some have been studied for many years, including notable caves on the former Beck Ranch. Some of the first formal, scientific studies of Texas cave life were conducted on the Beck Ranch in the 1970s by Dr. Robert Mitchell of Texas Tech University. His studies indicate Beck Bat Cave, Beck Crevice Cave (which is now considered smaller feature within Beck Bat Cave), Beck Horse Cave, Beck Pride Cave, and Beck Tex-2 Cave are known to contain the Bone Cave harvestman. Two other caves, Beck Salamander Cave and Beck Creek Cave, are not known to contain endangered fauna but may be connected to the other caves. Each cave is considered an aquifer recharge feature. The Beck Preserve constitutes a potential KFA because of its size and relative distance between Texella occupied caves and surrounding development, as indicated within the RHCP (SWCA et al. 2008). However, the WCCF has not yet submitted an application to the USFWS as part of the process for recognition that the Beck Preserve is officially contributing to the Bone Cave harvestman's recovery as a KFA.

Table 3. Basic Information for the Beck Preserve

Beck Preserve Information	
Preserve Inception Year	2009
Acreage	44.5
Fence Status	Fence separates preserve from adjacent school. No other fence.
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Beck Tex-2, Beck Salamander, Beck Horse, Beck Bat, Beck Pride, Beck Creek and Beck Crevice Caves
Non-gated Caves	None

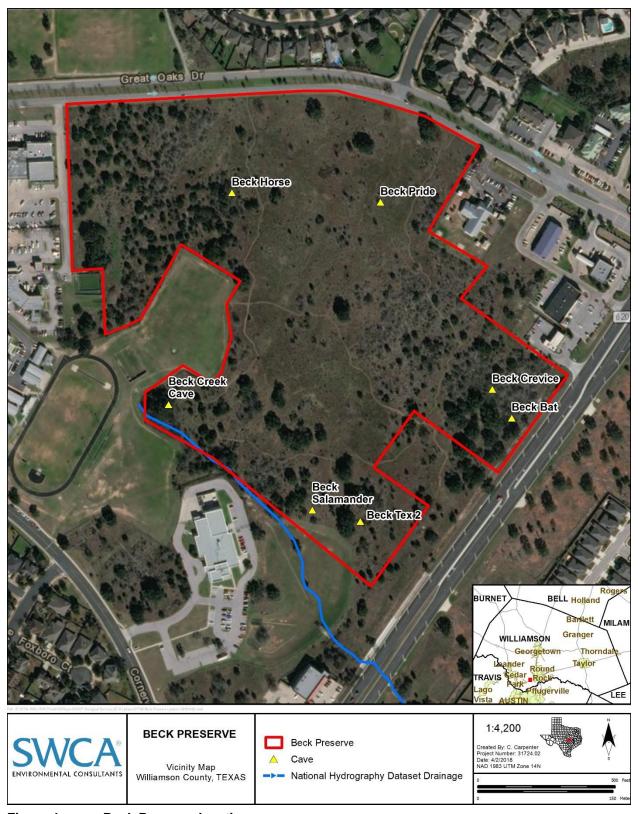


Figure 4. Beck Preserve location map.

The Beck Preserve is located at the southern end of one of the densest cave concentrations known within the Bone Cave harvestman range. Approximately 50 caves have been documented from an area measuring approximately 1.5 miles long north/south by 1 mile wide east/west. The Beck Preserve is adjacent to the Brushy Creek Municipal Utility District, which contains 13 additional caves on four nearly contiguous parcels beginning on the north side of Great Oaks Drive and stretching for a mile to the north beyond O'Connor Drive. Eight of those caves are confirmed to contain the Bone Cave harvestman. Approximately 500 feet northeast of the Beck Preserve between Great Oaks Drive and Scott and White Drive is an approximately 2-acre setback containing Vault and Imprint caves. Approximately 1,500 feet northeast of the Beck Preserve is a parcel containing Beck Sewer Cave and Beck Tin Can Cave maintained by the WCCF as the Beck Commons Preserve (Section 3.12). Immediately across RM 620 from Beck Preserve is the Highland Horizon tract, which contains 12 caves occupied by the Bone Cave harvestman plus several addition caves. Robinson Ranch contains several occupied caves approximately 0.5 mile east from Beck Preserve, and additional acreage on the ranch has not been surveyed for karst features. Some of these caves are potentially connected to caves within Beck Preserve, at least from an invertebrate's point of view. Although this potential is difficult to quantify, it appears to be greatest at the following locations: Jackhammer Cave,<sup>2</sup> which is located partially under RM 620 approximately 275 feet from Beck Tex-2 Cave; Trouser Press Cave, which is located adjacent to RM 620 approximately 490 feet from Beck Tex-2 Cave; and Anteater's Delight<sup>3</sup> Cave, which is located immediately adjacent to the east side of RM 620 less than 200 feet from the edge of the footprint of Beck Bat Cave.

The Beck Preserve currently maintains a fence separating it from the adjacent Cedar Valley Middle School. All other portions remain unfenced; however, staff from the middle school maintain a constant presence to prevent truant students from bypassing the existing fence and accessing Beck Preserve. Additionally, Beck Tex-2, Beck Salamander, Beck Horse, Beck Bat, Beck Pride and Beck Crevice Caves all have cave gates blocking access to their respective caves.

# 2.2.2 Hydrogeology

The Beck Preserve is located entirely within the Edwards Aquifer Recharge Zone (EARZ) (Figure 5). Based on regional trends, the direction of groundwater flow from Beck Preserve is likely the northeast. Recharge from Beck Preserve likely contributes baseflow to Brushy Creek, but no formal study has been conducted.

<sup>&</sup>lt;sup>2</sup> Jackhammer Cave was sealed as result of RM 620 expansion and was a confirmed *Texella reyesi* locality.

<sup>&</sup>lt;sup>3</sup> Anteater's Delight was sealed as a result of development activity and was not a known *Texella reyesi* locality.

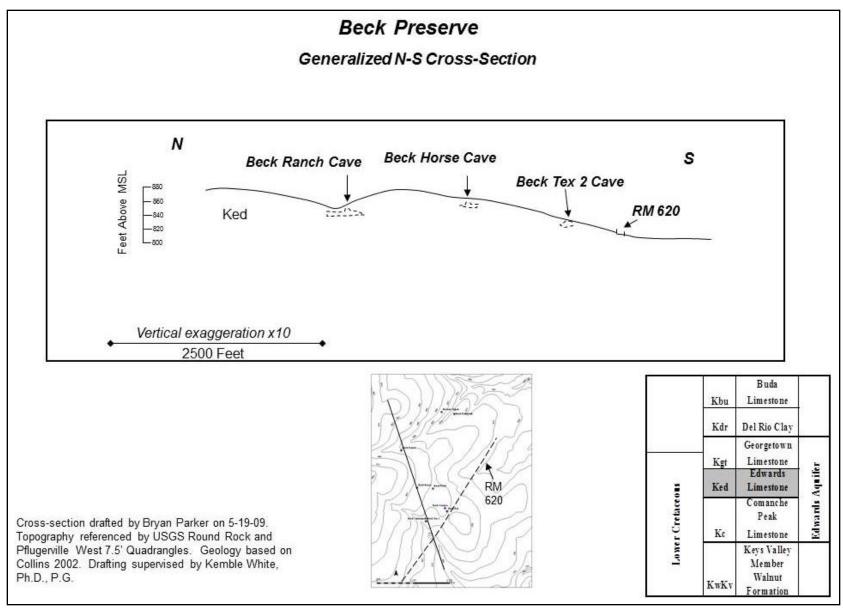
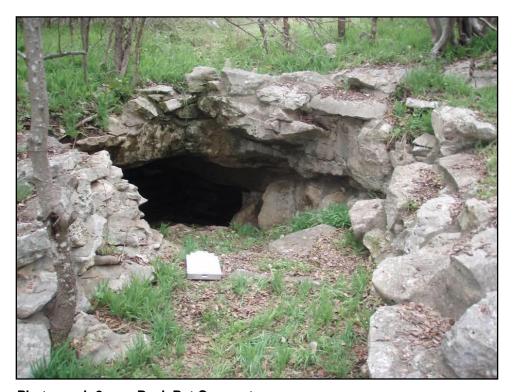


Figure 5. Beck Preserve geology.

### 2.2.3 Caves of the Beck Preserve

Cave maps are included within Appendix B.

**Beck Bat Cave:** Beck Bat Cave is the most notable feature on the site with records kept by cave explorers as early as the 1950s (Photograph 2). Beck Bat Cave contained a colony of "Mexican brown bats" (*Myotis velifer*, now known as cave myotis) as recently as 1989, but disturbance from human visitation prior to preserve acquisition and cave gate installation caused them to relocate. The cave entrance measures approximately 8 feet in diameter, sloping to the north beneath a ledge of bedrock. The cave primarily consists of a single large, wide room, divided into two main areas by a sizable ceiling collapse. Two small, lower-level rooms are at the northern extent of the cave. The cave dimensions measure approximately 163 feet long by 91 feet wide, with a maximum depth of 22 feet. This cave is known to contain the Bone Cave harvestman (Table 4). A blind *Batrisodes* was located during the 2017 annual biota survey, which is a finding with potentially significant conservation implications. Dr. Donald S. Chandler at the University of New Hampshire determined this species is *Batrisodes reyesi*, which represents a significant range expansion to the east for the species. A cave gate currently prevents unauthorized access to this feature.



Photograph 2. Beck Bat Cave entrance.

**Beck Crevice Cave:** Beck Crevice Cave is approximately 100 feet from the entrance of Beck Bat Cave and two features share structural connection. The cave entrance drops 5 feet into a low bedding plane room that extends for approximately 30 feet toward Beck Bat Cave. The passage is formed along a rock joint trending approximately N40E. The footprint of the cave measures approximately 22 feet wide by 38 feet long, with a maximum depth of 18.2 feet. This cave is known to contain the Bone Cave harvestman (see Table 4) but is no longer monitored due to its small size and connectivity with the larger, Beck Bat Cave.

**Beck Horse Cave:** The Beck Horse Cave entrance is approximately 10 feet in diameter, sloping beneath the north headwall into a large room (Photograph 3). The cave is formed along a rock joint trending N21E. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.



Photograph 3. Beck Horse Cave entrance.

**Beck Pride Cave:** Beck Pride Cave is Beck Preserve's most biologically diverse cave. The cave entrance drops approximately 15 feet to the main room, which was formed along a rock joint trending approximately N16E. The cave contains upper-, mid-, and lower-level extents, all controlled along this same rock joint. The main passage extends to the north mainly as a walking size passage until it pinches off at a low bedding plane. The cave also extends to the south along the mid-level as a low, wide bedding plane passage. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.

**Beck Tex-2 Cave:** Beck Tex-2 Cave is very shallowly developed, with a bedding plane level beginning at 3 feet below the ground surface that slopes down to the west (Photograph 4). The surveyed length of the cave is 69.6 feet. The cave footprint measures approximately 20 feet wide by 32 feet long, with a maximum depth of 10.6 feet. This cave is known to contain the Bone Cave harvestman (see Table 4). A cave gate currently prevents unauthorized access to this feature.



Photograph 4. Beck Tex-2 Cave entrance.

**Beck Salamander Cave:** The Beck Salamander Cave entrance drops vertically into an enlarged rock joint trending N30E (Photograph 5). The cave measures approximately 11.4 feet long, with a maximum depth of 12.1 feet. This cave is not currently known to contain any endangered karst invertebrates (see Table 4). A cave gate currently prevents unauthorized access to this feature.



Photograph 5. Beck Salamander Cave entrance.

**Beck Creek Cave:** The Beck Creek Cave entrance headwall resembles that of Beck Bat Cave and Beck Horse Cave; however, the passage is completely blocked by massive in-filled rocks and sediments. The cave was backfilled with the use of a dozer in the past, and an attempt to re-open the cave was unsuccessful. This cave is not currently known to contain any endangered karst invertebrates (see Table 4). A cave gate currently prevents unauthorized access to this feature, though this cave is not currently surveyed for karst biota.

Table 4 shows documented species within the Beck Preserve.

Table 4. Species Documented from the Beck Preserve

	Species	Beck Bat Cave	Beck Pride Cave	Beck Horse Cave	Beck Crevice Cave	Beck Tex-2 Cave	Beck Salamander Cave	Beck Creek Cave
Permitted Species								
Texella reyesi		√	$\checkmark$	<b>V</b>	$\sqrt{}$	$\checkmark$		
Other Species								
Crickets	Ceuthophilus sp.	√	$\sqrt{}$	√	$\sqrt{}$	$\sqrt{}$	$\checkmark$	<b>V</b>
	Cicurina varians	√	$\sqrt{}$	√	$\sqrt{}$	$\sqrt{}$		
	Cicurina buwata	√	$\checkmark$	$\checkmark$	V	$\sqrt{}$		
	Tayshaneta sp.	$\sqrt{}$		√				
	Eperigone albula	$\sqrt{}$						
	Anapistula sp.	$\sqrt{}$		$\checkmark$				
Arachnids	Agyneta llanoensis	<b>√</b>						
Araciinius	Araneae	<b>√</b>	$\checkmark$	√	$\sqrt{}$	√	V	√
	Eidmannella sp.	√		√				
	Cryptachaea porteri		$\checkmark$		$\sqrt{}$	√		
	Pseudouroctonus reddelli	<b>√</b>						
	Lechytia sp.			√				
	Pseudoscorpion	<b>√</b>	<b>V</b>					
	Speodesmus bicornourus	$\sqrt{}$	$\sqrt{}$	√			√	
	Cambala speobia	<b>√</b>	<b>V</b>	√	√	√		
Millipedes/	Oxidus gracilis			√	<b>√</b>			
Centipedes	Myrmecodesmus sp.		<b>V</b>					
	Scolopendra sp.		<b>V</b>				√	
	Scutigeridae	<b>V</b>	<b>V</b>			√		
	Rhadine subterranea	<b>√</b>	$\sqrt{}$	√				
Beetles	Coleoptera	<b>√</b>			√		√	
	Staphylinidae	√		V	V		√	√
	Anillinus sp.	√						
	Eustilicus condei	√						
	Biblioplectus sp. nr. ruficeps			<b>V</b>				
	Batrisodes uncicornis	<b>V</b>	$\sqrt{}$	√	$\checkmark$	√		
	Batrisodes reyesi	<b>√</b>						
	Tachys ferrugineus	<b>√</b>						
	Tachyini							√

	Species	Beck Bat Cave	Beck Pride Cave	Beck Horse Cave	Beck Crevice Cave	Beck Tex-2 Cave	Beck Salamander Cave	Beck Creek Cave
Reptiles/ Amphibians	Plethodon albagula						<b>V</b>	
	Eleutherodactylus marnockii	<b>√</b>	<b>√</b>	√				
Mammals	Perimyotis subflavus	$\checkmark$	<b>√</b>	√		√	<b>√</b>	
	Myotis velifer	√		√				
	Mouse			√				
	Procyon lotor		<b>V</b>					
	Desert Cockroach		<b>V</b>					
	Blattaria							√
	Collembola sp.	√	√	√	√	<b>V</b>	<b>√</b>	√
	Isopod (pillbug)	√	√	√	<b>V</b>	<b>V</b>		√
	Earthworm							√
	Gastropoda (Slugs/Snails)	<b>√</b>	<b>V</b>	√		<b>V</b>	√	√
	Formicidae			√	√			
	Solenopsis invicta	<b>√</b>	<b>V</b>	√		<b>V</b>	√	√
	Lepidoptera	√		<b>√</b>				
	Psocoptera			√				
	Thysanoptera			√				
Other	Hymenoptera					<b>V</b>		
	Flea	<b>√</b>					√	
	Fly			√		<b>V</b>	√	
	Gnat	<b>√</b>					√	
	Mite	√	√		√			√
	Mosquito						<b>√</b>	
	Streblidae	√						
	Diptera	√		V				
	Helicodiscus sp.	√	√	V		√	√	
	Diplura	√						
	Annelid	√						
	Assassin Bug			√				

# 2.3 Cobbs Cavern Karst Fauna Area

### 2.3.1 Introduction

The Cobbs Ranch comprises approximately 1,670 acres and is approximately 5 miles northwest from the City of Georgetown (Figure 6). The WCCF received a Recovery Land Acquisition grant through the Cooperative Endangered Species Conservation Fund and authorized by Section 6 of the ESA, to provide 75% of the cost to purchase a conservation easement. The federal grant required a 25% local match, which was donated by the Lyda Family Trust as land. The grant was awarded to the County in September 2005. The County executed a conservation easement contract with the Lyda Family Trust to establish the 64.4-acre conservation easement in November 2006. The WCCF was awarded additional Section 6 funds in 2011, which were used to acquire the conservation easement for an additional 98 acres surrounding the entire Cobbs Cavern footprint. This acquisition completed the approximately 163.0-acre Cobbs Cavern KFA (Table 5), which was approved by the USFWS in October 2011. The ranch consists of live oakjuniper savanna on gently rolling uplands drained generally to the east by the Cobbs Spring branch and other tributaries to Berry Creek. The property is located within the northern Balcones Fault Zone (BFZ) and within the northern segment of the EARZ.

The spring system that created the extensive cavern system created a multitude of ecological niches inhabited by some of the rarest, most unique, and endangered organisms in Texas. Cobbs Cavern is one of the 30 longest caves in the state, with over 4,500 feet of passage, all of which is located within the conservation easement. It is home to at least six species of rare and endangered terrestrial karst invertebrates, including two covered species and four additional species as listed in the RHCP (Table 6). The conservation easement contains a significant portion of the springshed for Cobbs Spring, which is known to contain a population of the Georgetown salamander (Figure 7).

Table 5. Basic Information for the Cobbs Cavern KFA

Cobbs Cavern KFA Information				
Preserve Inception Year	Acquired easements 2006, 2011			
Acreage	163.0			
Fence Status	None- However, the greater ranch is fenced			
Sign Status	None- Private property			
Baseline Vegetation Survey Date	2013			
Owner	Easement- Lyda Family Trust			
Gated Caves	Cobbs Cavern			
Non-gated Caves	None			

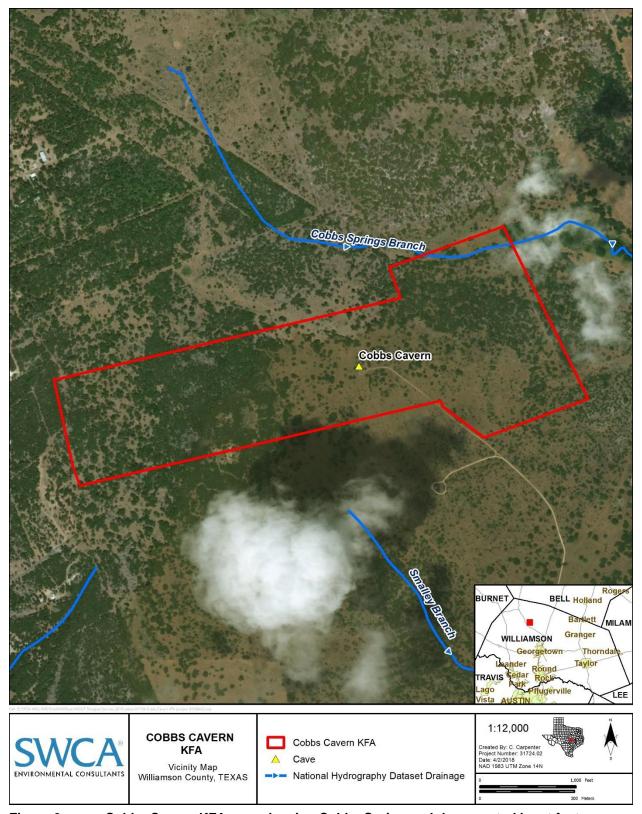


Figure 6. Cobbs Cavern KFA map showing Cobbs Spring and documented karst features.

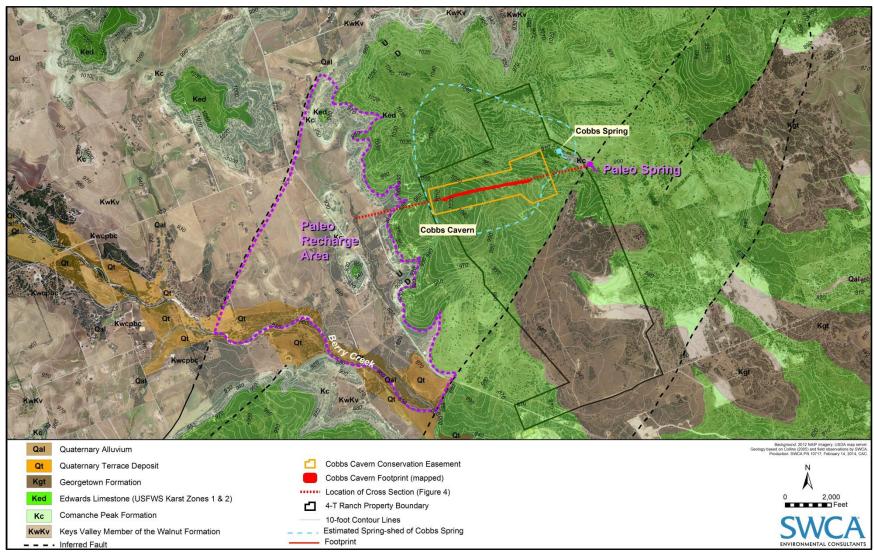


Figure 7. Cobbs Ranch geology and idealized springshed hydrology for Cobbs Spring.

Certain activities were mandated by the final conditions of the Cobbs Cavern KFA agreement. Although the 163-acre KFA is not currently fenced, most of the 1,670-acre Cobbs Ranch that surrounds it is fenced. The remote location of the Cobbs Ranch and metal gating on the entrances to Cobbs Cavern helps minimize trespassing potential. Livestock no longer have access to the KFA. A rock wall near the cave entrance that required modification has been replaced by a French drain and the area has been revegetated with native grasses. A roof extension that was covering the main entrance to the cave has been removed to allow more natural movement of air and rainfall access to the cave entrance. However, the roof removal has allowed increased air circulation at the cave entrance and troglobitic species have moved farther back into the feature recesses to avoid surface climate conditions. Finally, a spill plan and secondary containment unit related to a Pedernales Electric Cooperative (PEC) transformer has not been implemented. Repeated contact with the PEC has resulted in an agreement that the unit will be removed, however the company has not actually done so. Due to the fact that the transformer is not electrified, contains no polychlorinated biphenyls (PCBs), sits at ground level, and is over 1.75 miles from the main entrance to Cobbs Cavern, contamination from the transformer is unlikely.

# 2.3.2 Hydrogeology

Cobbs Cavern and Cobbs Spring are part of an integrated karst hydrologic system contained within the discrete section of Edwards limestone defined by the fault, which passes approximately 1,800 feet southeast of the spring outlet and erosional removal of the Edwards by tributaries of Salado and Berry Creeks to the northwest of the fault (see Figure 7). The maximum theoretical springshed consists of all rocks that are higher than the stratigraphic position and elevation of the spring due to the unconfined nature of the aquifer. However, in the area surrounding the property, there are numerous incisions into the Edwards outcrop formed by drainages other than Cobbs Springs Branch. It is a predictable regional pattern that significant incision into the Edwards outcrop form groundwater discharge points at the Edwards/ Comanche Peak contact, ranging from very low flow seeps supporting slightly more luxuriant vegetation than surrounding areas to permanent springs such as Cobbs Spring. Twelve permanent springs (including several other Georgetown salamander locations) and numerous seeps occur along this lithologic contact within a 10-mile radius of the property. These additional discharge points constrain the boundaries of the actual recharge area that contributes to Cobbs Spring and were subtracted from the idealized springshed shown in Figure 7. A geologic map property was produced from geologic maps compiled at the University of Texas Bureau of Economic Geology and on-site field mapping by SWCA (see Figure 7).

Figure 8 presents a cross-sectional illustration of the hydrologic mechanism behind the spring flow. The Comanche Peak is a relatively impermeable unit that perches groundwater working its way down through the overlying Edwards limestone. Groundwater moves laterally along the contact between the two units and downhill (the fault block upon which the recharge area sits is tilting toward the southeast at about 40 feet per mile) until it finds daylight, where the down cutting of Cobbs Springs Branch exposes the Comanche Peak. Spring flow was probably initiated when the bed of Cobbs Springs Branch intersected the Comanche Peak along the fault plane, which is approximately 1,800 feet downstream from the current spring outlet (see Figure 8).

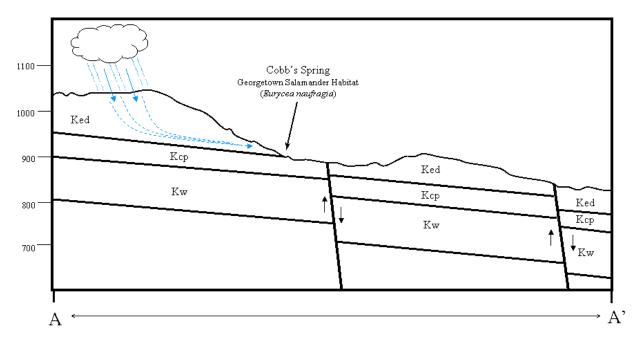


Figure 8. Cobbs Spring cross-sectional representation showing hydrologic mechanism behind spring flow.

Headward erosion has caused the spring outlet to gradually move upstream. This is evidenced by the trend of Cobbs Cavern itself. Extending the linear trend of the cavern along its bearing to the northeast produces a line pointing directly to the intersection of the fault plane with the current spring run. The cave, therefore, appears to be a paleo-channel pointing to the location of the paleo-spring outlet. Based on the above understanding of site hydrology, the springshed of Cobbs Spring is approximately 750 acres, with approximately 16% of the springshed occurring within the boundaries of the current conservation easement.

#### 2.3.3 Caves of the Cobbs Cavern KFA

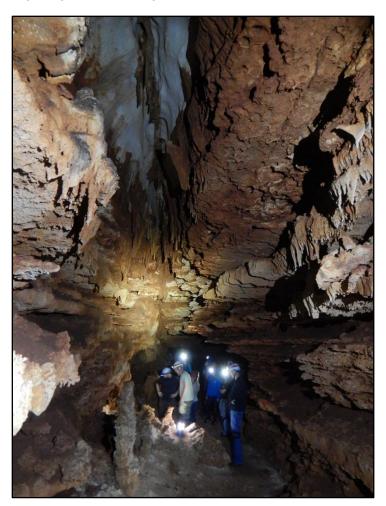
Cave maps are included within Appendix C.

Cobbs Cavern: Cobbs Cavern can be thought of as two caves within one. Cobbs Cavern's eastern third was operated on a limited basis as a show cave in the late 1960s and early 1970s (Photograph 6). The "Show Side" has been made easily traversable with a wide walking path in the cave's center. Visitors have to stoop in a few places, but the cave is otherwise very easy to move through with no tight squeezes or areas that require crawling. Public access to the cave has been restricted since that time, but the old visitor center building remains. The western two-thirds of Cobbs Cavern is called the "Wild Side" and is in a natural state with difficult to travel terrain and muddy, tight squeezes not suitable for novice cave exploration. The Bone Cave harvestman and the Inner Space Caverns mold beetle are known from Cobbs Cavern. A cave gate currently prevents unauthorized access to this feature.

Despite concerns about the potential effects of entrance modification and trail construction associated with tourism activities, the invertebrate fauna of the cave remains quite diverse. Aside from the rare species listed above, the cave community also includes at least two species of *Ceuthophilus* cave crickets, *Cambala* millipedes, *Texoreddellia* silverfish, *Pseudouroctonus* scorpions, *Eidmannella* spiders, *Collembola* (springtails), and mites. Cobbs Cavern is one of the 30 longest caves of more than 6,000 caves in Texas. Cobbs Cavern and associated non-navigable void network is one of the single largest habitats known for endangered karst invertebrates in the State.

Two karst feature excavations west of the mapped end of the cave have revealed troglobitic *Cicurina* spiders and *Speodesmus* millipedes. This indicates that the Cobbs Cavern habitat extends at least 1,000 feet beyond the mapped passage and that additional loci of nutrient input occur in addition to the known entrances at either end of the former tourist trail.

A wildfire burned across most of the conservation easement during the summer of 2008, creating several opportunities for additional investigation. Several significant karst features that were previously hidden by dense brush were located, including an old entrance to the cave and several sinkholes indicating additional passage (and troglobite habitat) beyond the cave's eastern-mapped end during a site inspection following the fire. Shrubby vegetation regrowth following the fire may lead to BCVI habitat creation and potential occupation. Migrating BCVI were sighted on the ranch in 2004.



Photograph 6. Photograph of the interior of Cobbs Cavern.

Cobbs Cavern KFA protection is significant to covered karst invertebrate species recovery and additional species conservation due to likely genetic distinctiveness. Cobbs Cavern is the northern-most documented location for the Bone Cave harvestman (*Texella reyesi*) and several additional troglobites (Photographs 7–12). It is also notable as the first known location for the species *Tayshaneta anopica* (Photograph 13). This spider lacks eyes entirely (as the scientific name suggests) and is considered a very advanced troglobite. Two of its close relatives (*Tayshaneta microps* from Bexar County and *T. myopica* from

Travis/Williamson County) are listed as endangered but are not as advanced in their troglomorphy, as they have eyes of reduced size.

In January 2005, SWCA conducted a cursory analysis of the likely drainage area that contributes water to Cobbs Spring to determine how much area would be preserved by conservation bank establishment. SWCA estimated the springshed area using several local geologic parameters. The property's lithological outcrops are Cretaceous in age and consist of the Georgetown limestone, Edwards limestone, and a previously unmapped outcrop of the Comanche Peak limestone (see Figure 7). The Georgetown and Edwards limestones are relatively transmissive units that form an unconfined karstic aquifer perched above the Comanche Peak limestone, which does not support easy movement of groundwater due to higher marl content. One normal fault crosses the property and produces an abrupt change in surface lithology from the Edwards limestone on the up-thrown block to the Georgetown Limestone on the downthrown block (see Figures 7 and 8). Table 6 shows documented species within Cobbs Cavern.



Photograph 7. Bone Cave harvestman close up in Cobbs Cavern.



Photograph 8. Batrisodes texanus next to gloves in Cobbs Cavern.

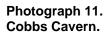


Photograph 9. *Cicurina vibora* consuming Ceuthophilus cricket.



Photograph 10. Speodesmus bicornourus in Cobbs Cavern.





Cicurina vibora collected in



Photograph 12. Cobbs Spring.

Eurycea salamander at



Photograph 13. Tayshaneta anopica collected in Cobbs Cavern.

Table 6. Species Documented from the Cobbs Cavern KFA

	Species	Cobbs Cavern				
	Permitted Species					
Texella reyesi	V					
Batrisodes texanus	Batrisodes texanus					
	Other Species					
Crickets	Ceuthophilus sp.	V				
	Cicurina varians	$\checkmark$				
	Cicurina vibora	$\checkmark$				
	Anipistula sp.	√				
Anachuida	Tayshaneta anopica	V				
Arachnids	Eidmannella sp.	V				
	Achaearanea sp.	√				
	Pseudouroctonus reddelli	V				
	Pseudoscorpion	√				
	Speodesmus bicornourus	$\checkmark$				
	Cambala speobia	√				
	Geophilomorpha	√				
Millipedes/ Centipedes	Scutigeridae	√				
	Oxidus gracilis	√				
	Scolopendra sp.	√				
Bastler	Staphylinidae	$\checkmark$				
Beetles	Rhadine noctivaga	V				
	Eleutherodactylus marnockii	$\checkmark$				
5	Incilius nebulifer	V				
Reptiles/ Amphibians	Lithobates berlandieri	V				
	Crotalus atrox	V				
	Bassariscus astutus	V				
Managasta	Procyon lotor	V				
Mammals	Perimyotis subflavus	V				
	Myotis velifer	V				
	Isopod	V				
	Texoreddellia aquilonalis	V				
Other:	Gnats	V				
Other	Collembola sp.	V				
	Helicodiscus sp.	V				
	Gastropoda	V				

## 2.4 Millennium Preserve

#### 2.4.1 Introduction

Williamson County purchased the approximately 800-acre Southwest Williamson County Regional Park (Regional Park) in 2002 with County bond money supplemented by funding from TxDOT. The Regional Park is located northeast of the intersection of Farm-to-Market Road (FM) 1431 and CR 175 near Leander, Texas, and encompasses the Wilco and Millennium Preserves (Table 7). The Regional Park's developed portion contains recreational facilities including ball fields, tennis courts, a track, disc golf course, and miniature train track. Most Regional Park acreage is open space, including two dedicated preserves for the Bone Cave harvestman and additional species. Other caves occur in open space outside of the karst preserves. The Regional Park occurs within the Georgetown KFR and its two preserves were identified by the USFWS as a potential KFA in the 5-year review of Bone Cave harvestman (USFWS 2018b). The Regional Park occurs adjacent to areas identified in the RHCP (SWCA et al. 2008) as potential habitat for the GCWA, and woodland within the park may become suitable for GCWAs over time. The WCCF headquarters is located within the Regional Park and maintenance staff are able to visit cave entrances on a regular basis.

An undefined portion of the park is recognized by the USFWS as a karst conservation area, as shown in Table 3-1 of the RHCP. The WCCF has requested that the Millennium Preserve be considered for full KFA status by the USFWS and the final decision is still pending. The County received funding from TxDOT in conjunction with the SH 45 Section 7 ESA consultation. These funds contributed to the 129-acre preserve land establishment to protect the ecological integrity of four high-quality caves within the park.

The Regional Park is geologically representative of a broader, highly cavernous area within the northern segment of the EARZ. This cavernous area contains dozens of caves and stretches for approximately 1.5 miles to the south and east. The Regional Park consists primarily of broad, flat uplands drained to the south by Brushy Creek tributaries. Total relief is approximately 60 feet, ranging from 870 to 935 feet amsl.

Table 7. Basic Information for the Millennium Preserve

Millennium Preserve Information	
Preserve Inception Year	2002
Acreage	74.4
Fence Status	Open-ended fences surround species caves
Sign Status	Signs posted on fences, warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Through Trip, Little Demon, Millennium, Fence and Trail
Non-gated Caves	Knuckle, Cap, Forest Elms Sink

Mike Warton and Associates (2000) and Horizon Environmental Services (2002) collectively described 39 features including caves, sinkholes, solution cavities, and fracture zones within the Regional Park. All features in the park are formed in the Edwards limestone, which is approximately 80 feet thick in the area. The surface expression of caves and other karst features is found generally, but not exclusively, above 900 feet in elevation, and karst features are rarely expressed within a 1,600-foot-wide zone coincident with the primary drainage channel running northwest to southeast through the undeveloped portion of the Regional Park. Two distinct karst areas are divided by this zone: The Millennium Preserve includes Millennium, Little Demon and Through Trip Caves (plus four other minor caves); whereas the Wilco Preserve contains Wilco, Wild West, Rock Ridge, and Mongo Caves (plus nine other minor caves or karst features). Figure 9 shows both the Millennium and Wilco Preserves in cross section to demonstrate the geologic separation between them.

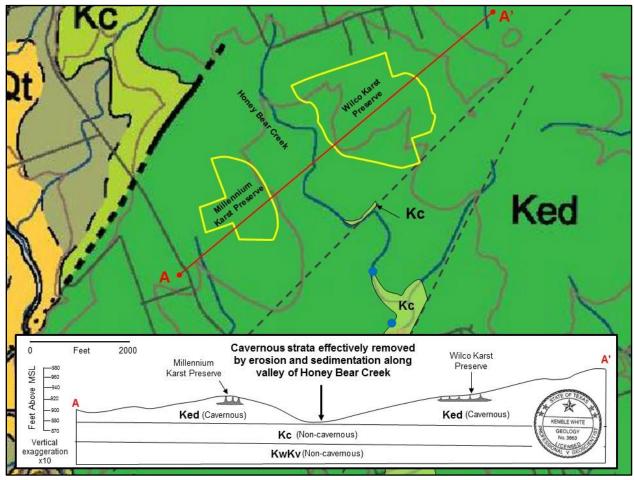


Figure 9. Geologic cross section across Millennium and Wilco Preserves highlighting karst erosion by Honey Bear Creek.

The 74.43-acre Millennium Preserve maintains fences containing appropriate signage strategic placed to direct the public away from the many of the caves. However, the fences are open-ended and this is a popular location with many trails designed for public-access hiking. A publicly accessible hike and bike pathway extends through Beck Preserve's western side but does not pass within either the drainage or ecological buffers established for the occupied caves. Cave gates prevent access to Millennium, Little Demon and Through Trip Caves. Figure 10 shows the Millennium Preserve and associated caves.

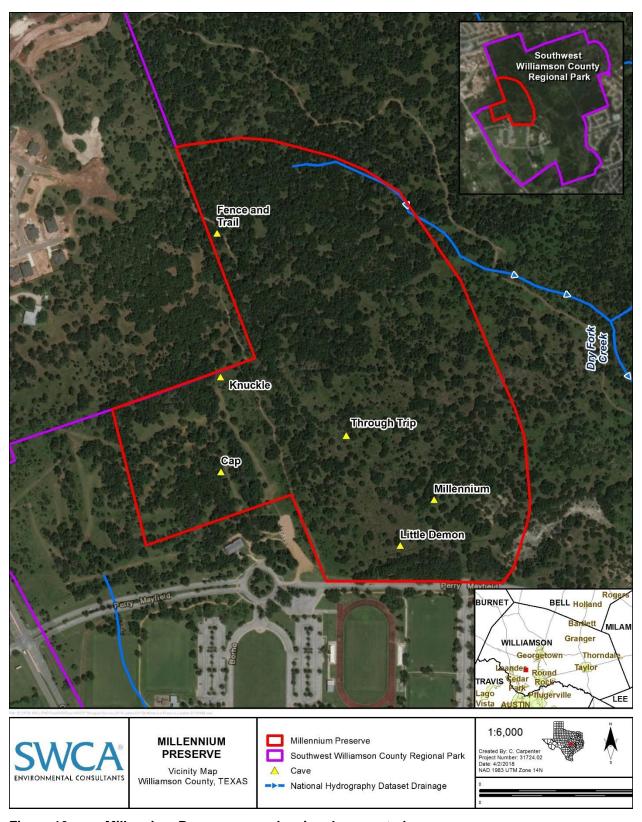


Figure 10. Millennium Preserve map showing documented caves.

## 2.4.2 Hydrogeology

Caves within the Millennium Preserve occur on the northeastern flank of a subtle southeast-trending ridge. Millennium Preserve slopes generally to the northeast contributing runoff to the Honey Bear Creek drainage basin, which is a tributary of Brushy Creek. Total relief on Millennium Preserve is approximately 40 feet ranging from 890 to 930 feet amsl. Most of the cave entrances are formed between 920 and 925 feet amsl and most traversable cave passage occurs between 905 and 925 feet amsl (Figure 11). Cave distribution suggests the presence of a well-developed, stratigraphically controlled dissolution zone that likely extends somewhat continuously beneath the ridge. This karstic horizon within the bedrock likely provides mesocavern habitat between the occupied caves and likely beyond.

The Millennium Preserve is entirely underlain by the Edwards limestone, which is the primary cavernous bedrock unit in the region (see Figure 11). The Millennium Preserve is on the EARZ's northern segment and groundwater recharge primarily occurs where the Edwards limestone is exposed at the surface through direct infiltration of precipitation on the limestone outcrop, through streamflow loss, and through secondary porosity features such as faults, fractures, and karst features (caves, solution cavities, sinkholes, etc.). The relatively flat terrain within Millennium Preserve is conducive to slow runoff, which enhances the potential for aquifer recharge. Groundwater perches at the base of the Edwards limestone where the underlying Comanche Peak acts as an aquitard and diverts flow laterally.

No faults are known to occur within the Millennium preserve, although fractures are expressed within all caves. A previously mapped fault passes approximately 0.5-mile northwest from the Millennium Preserve (Collins 2005). Field mapping by Cambrian personnel indicates the presence of at least two previously unmapped faults southeast from the Millennium Preserve.

The Edwards limestone is approximately 85 feet thick within the Millennium Preserve (Collins 2005; Senger et al. 1990). The Edwards limestone is near its full thickness at the Millennium Preserve's highest topography and is nearly breached along Honey Bear Creek (see Figures 9 and 10). It is this near breach of cavernous strata that provides an isolating mechanism between the Millennium and Wilco Preserves. The Honey Bear Creek basin follows an approximately 1,500-foot-wide erosion corridor where karst feature strata is generally absent. Field mapping indicates the Edwards limestone is only 5 feet thick within the basin's southern end and not more than 15 feet thick at the northern end of the corridor. The Edwards limestone pinches out altogether immediately south from the Millennium Preserve and groundwater can be observed discharging from several seeps along Honey Creek at the contact with the underlying Comanche Peak formation. The thin Edwards limestone remnant along the creek bottom area is covered with relatively thick clay soils which are absent from the Millennium Preserve's karstic uplands. Clay soil areas throughout the corridor are marked by mesquite trees and several small stock ponds that hold water after rains for an extended period (depressions on the Edwards typically do not hold water due to the porous nature of the rock). Low permeability, thin outcrop, and the general absence of karst features throughout this corridor indicate that suitable habitat for karst invertebrates is unlikely to occur there.

Surface drainage basin delineation is a relatively straightforward process based on the surface topography near cave entrances and other nearby features such as sinkholes or fractures with the potential to convey water into the cave. All caves within the Millennium Preserve have relatively limited surface drainage areas due to their upland locations. The species-occupied caves all draw their surface runoff from a ridge contained within the Millennium Preserve boundaries. Therefore, all surface runoff reaching the species-occupied cave entrances and footprints originates within the Millennium Preserve.

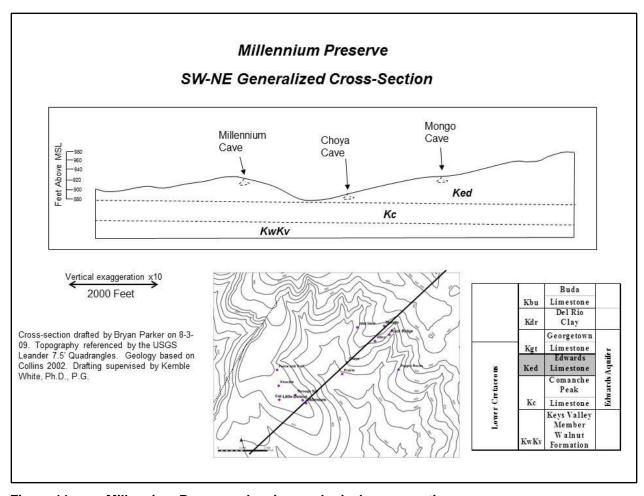


Figure 11. Millennium Preserve showing geological cross section.

### 2.4.3 Caves of the Millennium Preserve

Cave maps are included within Appendix D.

**Through Trip Cave:** The entrance to Through Trip Cave was excavated to 4.5 feet to find a horizontal passage (Photograph 14). A tunnel extended for 6.5 feet before becoming constricted. Further excavation located open passage leading west for approximately 30 feet. A small crawlway was further excavated and continues west for another 20 feet before leading to another small crawlway. This crawlway was excavated and led to another room continuing west. This opens immediately into a 7-foot-high passage and continues west for 40 feet before leading to another shaft within the rock joint. This shaft was revealed to be a second cave entrance. The surveyed cave length is approximately 105.9 feet, with a 16-foot maximum depth. The cave footprint measures approximately 80 feet long by 32 feet wide. This cave is not currently known to contain any endangered karst invertebrates and a cave gate prevents unauthorized access.



Photograph 14. Through Trip Cave west entrance.

**Little Demon Cave:** The Little Demon Cave entrance was excavated to 6 feet, where an additional 6-foot open drop was found (Photograph 15). Open cave passage was encountered at 12 feet. The mostly rock joint-controlled room trends N90W and contains several passages in various directions. The surveyed cave length measures approximately 75.6 feet, with a 19-foot maximum depth. The cave footprint measures approximately 45 feet long by 14 feet wide. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.



Photograph 15. Little Demon Cave entrance.

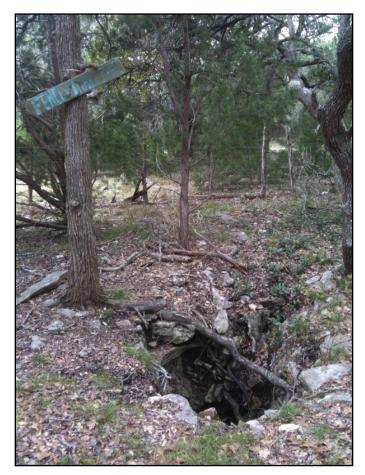
**Millennium Cave:** This cave had the only open entrance within the Regional Park that required no digging (Photograph 16). The entrance room is approximately 28 feet long, and at the end, a digging lead was pursued. A large room was encountered at 6 feet deep after additional excavation. This room measures approximately 40 feet in diameter with a floor-to-ceiling height of 4.5 feet. The surveyed cave length is approximately 82.7 feet, with a 29-foot maximum depth. The cave footprint measures approximately 80 feet long by 35 feet wide. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.



Photograph 16. Entrance to Millennium Cave.

The Millennium Preserve contains four additional caves and sinkholes not currently known to contain habitat for troglobitic fauna. This is primarily due to their small size and inaccessibility for researchers. However, the collective karst feature distribution suggests the Millennium Preserve's cave-containing strata are an interconnected cavernous and mesocavernous habitat area spanning more than 20 acres. The cave geomorphology suggests they formed from a larger underlying karst void network collapse. That network likely formed under phreatic conditions in response to paleo-aquifer karst hydrology as groundwater followed an easterly to northeasterly path toward the confined aquifer zone. This process was initiated in the Miocene following the tectonic events that created the Balcones Escarpment (Senger et al. 1990; White 2009). Aquifer entrenchment and regional streams caused the water table to drop below the current cave elevation. The buoyant force acting on the cave ceilings was lost and the caves began to collapse when this happened. The cave floors that are accessible now are largely formed from breakdown material that has collapsed from the original cave ceiling. The modern cave network has chaotic morphology relative to the paleo cave network because the collapse process is incomplete. What formed as a relatively continuous void network formed in response to dissolution by flowing groundwater is now a seemingly discontinuous patchwork of air pockets from a human cave explorer's perspective. However, the mesocavern network is far more extensive and accessible from a karst invertebrate's perspective, which still emulate the original groundwater pathways.

Fence and Trail Cave: The entrance to Fence and Trail Cave was excavated to 7 feet deep where open passage was discovered (Photograph 17). The passage is formed along a rock joint trending N70E. The entrance extends through a tight constriction into a passage approximately 5 feet wide by 13 feet long, with 2-foot maximum floor to ceiling height. The surveyed cave length measures approximately 20 feet, with a maximum depth of 7 feet. The cave footprint measures approximately 20 by 5 feet. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.



Photograph 17. Entrance to Fence and Trail Cave.

**Knuckle Cave:** The Knuckle Cave entrance was excavated to 5 feet, where a small open cave was encountered (Photograph 18). The feature appears to be formed along a rock joint trending N30W. The cave extends to the southeast along a low bedding plane for about 20 feet. The surveyed cave length is approximately 29.2 feet, with a maximum depth of 7.3 feet. The cave footprint measures approximately 26 feet long by 11 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.



Photograph 18. Entrance to Knuckle Cave.

Cap Cave: Cap Cave consists of a large single solution cavity discovered during the Regional Park development. The entire footprint of the irregularly shaped feature is less than 15 feet in diameter and approximately 5 feet deep. The name "Cap" cave comes from the large flat boulder currently covering the entrance of the feature. No Cap Cave map is available. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.

**Forest Elms Sink:** Forest Elms Sink is so named due to the presence of a small grove of cedar elm trees, the largest of which have died since the feature was excavated in 2000. The feature consists of a small pit measuring approximately 5 feet in diameter. It was originally mapped as being up to 8 feet deep, but it appears that some slumping from the walls has filled the lower portion of the feature since it was excavated. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota, and does not have a gate.

Table 8 shows species documented from the Millennium Preserve.

Table 8. Species Documented from the Millennium Preserve

Species		Millennium	Little Demon	Through Trip		
	Permitted Species					
Texella reyesi		√	√			
	Other Species					
Cuintente	Ceuthophilus secretus	√	√	<b>√</b>		
Crickets	Ceuthophilus cunicularis	√	√	<b>√</b>		

	Species	Millennium	Little Demon	Through Trip
	Cicurina browni	√		V
•	Cicurina varians	√	V	<b>V</b>
,	Agyneta sp.	√		√
,	Anapistula sp.	√		<b>√</b>
,	Eidmannella sp.	√	V	
Arachnids	Tayshaneta sp.	√		
,	Araneae (General Spider)			<b>√</b>
,	Cryptachaea porteri	V	V	<b>√</b>
,	Leiobunum townsendi	√	V	<b>√</b>
,	Pseudouroctonus reddelli	√	√	
,	Pseudoscorpion		<b>√</b>	
	Speodesmus bicornourus	√		√
,	Cambala speobia	√	<b>√</b>	<b>√</b>
Millipedes/ Centipedes	Scutigeridae	√	√	<b>√</b>
	Lithobiomorpha	√	<b>√</b>	
	Scolopendra sp.	√		
	Anillinus sp.			<b>V</b>
	Staphylinidae	V	√	<b>V</b>
Beetles	Rhadine subterranea	√		
,	Batrisodes uncicornis	V	√	<b>√</b>
	Eleutherodactylus marnockii	V	√	<b>V</b>
,	Incilius nebulifer	V	V	<b>√</b>
Reptiles/ Amphibians	Gastrophryne olivacea		V	
,	Thamnophis sp.		V	
,	Rana berlandieri		√	<b>√</b>
	Arenivaga sp.	√		<b>√</b>
,	Isopod	√	<b>√</b>	<b>√</b>
,	Mouse			<b>√</b>
,	Texoreddellia sp.	√		
,	Assassin Bug		<b>√</b>	<b>√</b>
,	Helicodiscus sp.	√	<b>√</b>	<b>√</b>
	Surface Silverfish	√		
Other	Earthworm		√	
	Gnat		√	
	Mite		√	
	Wasp		√	
	Dark Springtail			<b>√</b>
,	Collembola sp.	√	√	√
	Annelid		√	

### 2.5 Wilco Preserve

### 2.5.1 Introduction

The Wilco Karst Preserve (Table 9) is located within the Regional Park near Leander, Texas (Figure 12) and was acquired by Williamson County under the same pretense as the Millennium Preserve. The flora and fauna have begun a successional transition from overgrazed, managed grassland to a predominantly native woodland/grassland mosaic from ranching cessation more than 15 years ago and provides suitable habitat for native species. The Wilco Preserve occurs adjacent to areas identified in the RHCP as potential habitat for the GCWA and woodland within the park may become suitable for GCWAs over time (SWCA et al. 2008). The WCCF has requested that the Wilco Preserve be considered for full KFA status by the USFWS and the final decision is still pending.

Table 9. Basic Information for the Wilco Preserve

Wilco Preserve Information	
Preserve Inception Year	2002
Acreage	152.5
Fence Status	Open-ended fences surround endangered species caves
Sign Status	Signs posted on fences, warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Wilco, Rock Ridge, Mongo, Wild West, Choya, Talus, No Paseo, Nuevo, Prospector, Venture
Non-gated Caves	Poppin Rocks, Circulation Sink, Lockout Sink, Side Pocket Sink, West Boundary Sink

# 2.5.2 Hydrogeology

Total relief on the Wilco Preserve is approximately 60 feet ranging from approximately 875 to 935 feet amsl. Land slopes generally from uplands in the northeast to drainages exiting the western and southern Wilco Preserve boundaries. The Honey Bear Creek drainage basin is immediately west from the Wilco Preserve and separates it from the Millennium Preserve. The Wilco Preserve is located entirely within the EARZ. Based on regional patterns, recharge from the property likely follows the groundwater gradient to the northeast, but no formal study has been conducted.

The Wilco Preserve caves with documented Bone Cave harvestman presence occur on either flank of a subtle southwest-trending ridge. Most cave entrances are formed between 910 and 925 feet amsl and most traversable cave passage occurs between 890 and 905 feet amsl (see Figure 9). This distribution suggests the presence of a highly developed, stratigraphically controlled dissolution zone which likely extends somewhat continuously beneath the ridge. This karstic horizon within the bedrock likely provides mesocavern habitat between the four occupied caves and likely beyond. The Edwards limestone is approximately 85 feet thick around Wilco Preserve (Collins 2005; Senger et al. 1990). Accordingly, the Edwards is near its full thickness near the highest topography and is nearly breached along Honey Bear Creek south from Wilco Preserve (see Figure 9). This near cavernous stratum breach provides an isolating mechanism between the Wilco and Millennium Preserves. No faults are known to occur within Wilco Preserve although fractures related to regional faulting are expressed within all of the caves. A mapped fault passes approximately 0.5-mile northwest of the Wilco Preserve (Collins 2005).

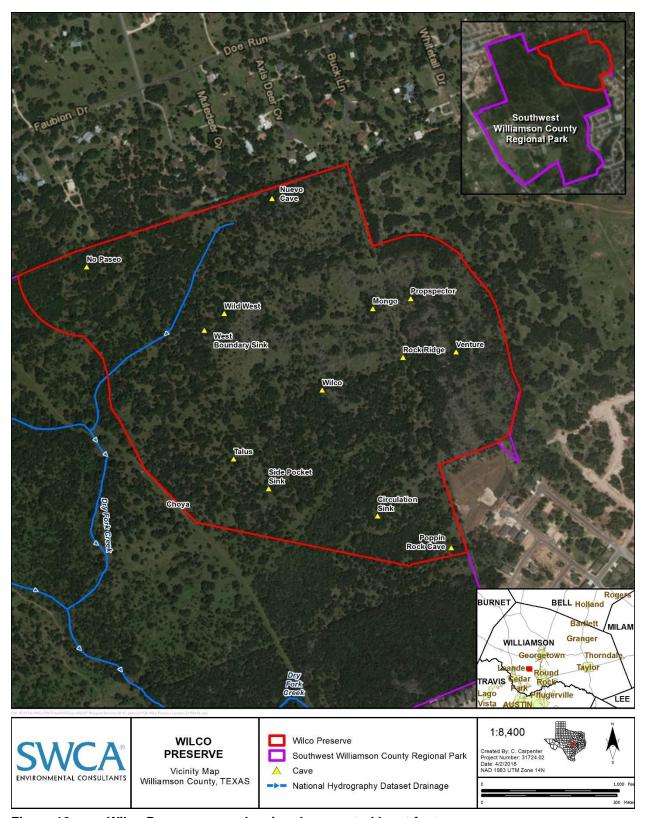


Figure 12. Wilco Preserve map showing documented karst features.

The Wilco Preserve caves have relatively limited surface drainage areas because of their upland terrain location. The species-occupied caves all draw their surface runoff from the ridge described above. Therefore, all surface runoff reaching the cave entrances and footprints originates from within the Wilco Preserve. The relatively flat terrain within the Wilco Preserve is conducive to slow runoff, which enhances the potential for aquifer recharge.

## 2.5.3 Caves of the Wilco Preserve

Cave maps are included within Appendix E.

The Wilco Karst Preserve contains Wilco Cave, Wild West Cave, Mongo Cave, and Rock Ridge Cave (all of which contain the Bone Cave harvestman), plus 10 additional significant karst features. Wilco Preserve contains the endangered Bone Cave harvestman along with a representative sampling of local endemic cave fauna including the troglobitic species *Cicurina browni, Tartarocreagris infernalis, Speodesmus bicornourus*, and *Rhadine subterranea mitchelli*, which are additional species addressed in the RHCP (SWCA et al. 2008). Additional fauna are likely to be detected in each cave now that regular biological monitoring is being conducted (Krejca and Weckerly 2007; Schneider and Culver 2004). Most Wilco Preserve caves are likely quite small relative to the volume of potential mesocavern habitat around and between the caves. A dominant east/west fracture trend is expressed in the morphology of all of the caves.

Wild West Cave: The Wild West Cave entrance was excavated to 4 feet and an open passage was encountered. The entrance opens to the west into a long linear room measuring approximately 18 feet wide by 40 feet long, with a 5.5-foot maximum floor to ceiling height. Access to a second lower-level room continues west from the main room's northwest corner. The lower-level room is wide and low and measures approximately 25 feet long by 35 feet wide, with a 3-foot maximum floor to ceiling height. The surveyed cave length is approximately 88.4 feet, with a 15.5-foot maximum depth. The cave footprint measures approximately 60 feet long by 38 feet wide. The cave is formed along a rock joint trending N90W and is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

**Mongo Cave:** Mongo Cave is located within the tract's largest sinkhole, which measures approximately 75 feet long by 50 feet wide by 6 feet high. The sinkhole is formed along a rock joint trending N90W and funnels down to a main drainage portal that was excavated to 3 feet before encountering open cave passage. The excavated entrance portal descends at a sharp angle for about 20 feet into a large single room measuring approximately 86 feet long by 41 feet wide, with a 6-foot maximum floor to ceiling height. A 12-foot-deep pit was excavated in this main room and a small lower-level room was located. No further extent was found. The surveyed cave measures approximately 167.8 feet long, with a maximum depth of 29.3 feet. The cave footprint measures approximately 86 feet long by 41 feet wide. Mongo Cave is the single largest cave known from the tract. This cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

**Rock Ridge Cave:** The Rock Ridge Cave entrance was excavated to 4.5 feet and open passage was located. The cave entrance and extent occur along a rock joint trending N85E. The cave extends primarily west for approximately 60 feet until passage becomes blocked. The cave also extends east from the entrance for approximately 20 feet. The eastern passage extends beneath the property boundary fence of the adjacent property. The surveyed cave length measures approximately 103.7 feet long, with a 14-foot maximum depth. The cave footprint measures approximately 80 feet long by 14 feet wide. Rock Ridge Cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.

**Wilco Cave:** Wilco Cave (Photograph 19) was excavated to 9 feet and a semi-open passage was encountered. A short passage leads west and drops down to a small room. A low bedding plane void extends south for an undetermined distance within this small room. The surveyed cave length measures approximately 47 feet long, with a 15.7-foot maximum depth. The cave footprint measures approximately 37 feet long by 27 feet wide. Wilco Cave is known to contain the Bone Cave harvestman. A cave gate currently prevents unauthorized access to this feature.



Photograph 19. Entrance to Wilco Cave.

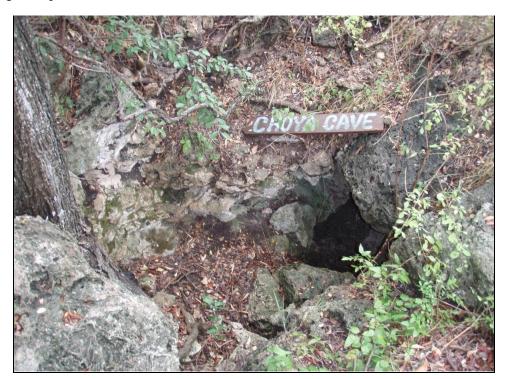
**Prospector Cave:** Prospector Cave is formed along a rock joint trending east 50 feet, with a 19-foot maximum depth. Further passage occurs below a drain and beyond restriction in the cave's terminal east end. Prospector Cave is formed within the same karstic horizon as the species-occupied caves and may represent an exposure of the occupied mesocavern habitat. It is especially close to Mongo Cave and may be directly connected. This cave is not currently known to contain any endangered karst invertebrates, is currently monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

**Venture Cave:** Venture Cave is formed along a rock joint trending northeast for approximately 70 feet, with a 21-foot maximum depth. Further passage occurs below a drain and beyond an air blowing restriction in the cave's terminal northeast extent. This cave is not currently known to contain any endangered karst invertebrates, is currently monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

**Talus Cave:** Talus Cave is within an approximately 40-foot diameter sinkhole that funnels down to a single portal. The portal was excavated to 9 feet where open passage was located. A constricted passage continued down at a sharp angle to 24 feet and a humanly accessible, cone-shaped collapse extends for approximately 15 feet. The surveyed cave length cave measures approximately 67.3 feet long, with a 24-foot maximum depth. The cave footprint measures approximately 43 feet long by 20 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.

**No Paseo Cave:** No Paseo cave was excavated 5 feet deep to reveal open passage extending both southwest and northeast. The passage extends approximately 20 feet from the cave entrance northeast and ends at a low bedding plane. The passage extends approximately 5 feet southeast before declining to an approximately 7-inch diameter drain that extends down vertically for about 7 feet. The surveyed cave length measures approximately 36.5 feet, with a 13.5-foot maximum depth. The cave footprint measures approximately 26 feet long by 11 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and a cave gate currently prevents unauthorized access.

**Choya Cave:** Choya Cave was excavated to 5 feet where open passage formed along a rock joint trending N40E (Photograph 20). The passage extends northeast for approximately 35 feet. The passage then extends northwest to an approximately 30-foot-long by 1-foot-wide room, with 4.5-foot maximum floor to ceiling height. The surveyed cave length measures approximately 155.8 feet long, with an 8.4-foot maximum depth. The cave footprint measures approximately 41 feet long by 31 feet wide. This cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access.



Photograph 20. Entrance to Choya Cave.

**Poppin Rocks Cave:** Poppin Rocks Cave was excavated 10 feet, where a larger cave structure was revealed. However, the passage is blocked by massive infill and collapse material. The accessible cave extent measures approximately 18.5 feet long, with a 10-foot maximum depth. This cave is not currently known to contain any endangered karst invertebrates, is not surveyed for biota and does not have a gate.

**Nuevo Cave:** Nuevo Cave was excavated to depth 4 feet, where a small, very low bedding plane passage was encountered. Cave extent follows a rock joint trending N90W into a very low room just a few feet below the ground surface level. The surveyed cave length measures approximately 21.3 feet long, with a 539-foot maximum depth. The cave footprint measures approximately 28 feet long by 10 feet wide. This

cave is not currently known to contain any endangered karst invertebrates, is not monitored for karst biota, and has a cave gate to prevent unauthorized access to this feature.

**Circulation Sink:** This sinkhole was enlarged sufficiently (Photograph 21) to allow entry to a small chamber with a low bedding plane void extending northwest for approximately 15 feet. Airflow comes from an additional cave passage that is not currently accessible. This feature is not known to contain endangered karst invertebrates, is not currently monitored for karst biota, and does not have a cave gate.



Photograph 21. Entrance to Circulation Sink.

**Lockout Sink:** This sinkhole was excavated 5 feet to expose a 3-inch-diameter solution cavity with airflow issuing from a low bedding plane. This feature is not known to contain endangered karst invertebrates, is not currently monitored for karst biota, and does not have a cave gate.

**Side Pocket Sink:** This sinkhole was enlarged sufficiently to allow entry to a small chamber measuring approximately 5 feet in diameter by 3 feet high with a low bedding plane void extending north for approximately 15 feet. Side Pocket Sink is formed within the same karstic horizon as the species-occupied caves and may represent occupied mesocavern habitat exposure, which could be an important nutrient input point between Wilco and Rock Ridge Caves. This feature is not monitored for karst invertebrates and does not have a cave gate.

**West Boundary Sink:** This sinkhole was excavated 4 feet to expose a bedding plane void extending to the east with airflow. The feature is very close to Wild West Cave and may represent mesocavern habitat connected to Wild West Cave. West Boundary Sink is formed within the same karstic horizon as the species-occupied caves and may represent occupied mesocavern habitat exposure. This feature is not monitored for karst invertebrates and does not have a cave gate.

Table 10 shows documented species within the Wilco Preserve.

Table 10. Species Documented from the Wilco Preserve

Spec	ies	Wild West Cave	Mongo Cave	Rock Ridge Cave	Wilco Cave	Prospector	Venture
		Permitte	d Species				
Texella reyesi		√	√	√	√		
		Other	Species	-			-
Crickets	Ceuthophilus secretus	<b>V</b>	√	√		<b>√</b>	√
Cilchets	Ceuthophilus cunicularis	<b>V</b>	√	√	<b>√</b>	<b>V</b>	√
	Cicurina browni	√	√	√		√	√
	Cicurina varians	√	√	√	√	√	√
	Tayshaneta sp.		√				
	Anapistula sp.	√	√		√		
	Agyneta sp.				√		
	Pseudoscorpion		√				
Arachnids	Eidmannella sp.						√
	Araneae	√		√			
	Achaearanea sp.		√				
	Cryptachaea porteri		√			V	√
	Mite					V	√
	Tick		√				√
	Leiobunum townsendi				√	<b>√</b>	√
	Speodesmus bicornourus		√	√	√		√
	Cambala speobia	√	√	√	√		
Millipedes/ Centipedes	Geophilomorpha						
	Scolopendra sp.		√				√
	Scutigeridae		√	٧		√	√
	Staphylinidae		V			√	
Donal	Anillinus sp.			√			
Beetles	Batrisodes uncicornis		√	√			√
	Rhadine subterranea		<b>√</b>				

Spec	ies	Wild West Cave	Mongo Cave	Rock Ridge Cave	Wilco Cave	Prospector	Venture
	Crotalus atrox	√	√				
Reptiles/ Amphibians	Lithobates berlandieri		√				
, , , , , , , , , , , , , , , , , , ,	Eleutherodactylus marnockii		√		<b>√</b>		√
Mammals	Perimyotis subflavus			√		√	√
Wammais	Myotis velifer		√				
	Arenivaga sp.	√	√	√	√		<b>√</b>
	Isopod	√	√	√	√	√	
	Assassin Bugs	√	√	√		√	√
	Helicodiscus sp.		√	√		√	√
	Collembola	√	√	√	√	√	√
Other	Bark Louse	√					
Other	Mosquito					√	
	Moth					√	√
	Flea	√					
	Earthworm	√	√		√	√	
	Fly		√				
	Gnat		√			√	√

### 2.6 Chaos Cave Preserve

### 2.6.1 Introduction

The approximately 30-acre Chaos Preserve (Table 11) is immediately south from SH 45 (Figure 13). It was established by TxDOT as a conservation measure related to potential Bone Cave harvestman impacts from SH 45 construction and Williamson County assumed management responsibility for Chaos Preserve in 2008. The County has agreed to preserve and protect the natural, scenic, open space, and ecological features in a contract for mitigation services between Williamson County and TxDOT dated August 26, 2008. Williamson County will also provide funding for management and monitoring activities and will report on those activities to TxDOT biannually.

Chaos Preserve is bounded by SH 45 to the north, by a rail line to the southwest, and by undeveloped portions of the Robinson Ranch to the east and west (see Figure 13). This area is a relatively flat upland drained to the north by Lake Creek. Elevations range from approximately 800 to 815 feet amsl (Figure 14).

Chaos, Under the Fence, and Poison Ivy Caves are confirmed as containing the Bone Cave harvestman. Karst invertebrates documented within the Chaos Preserve are included in Table 12. Immediately east from the Chaos Preserve are several additional caves, including Sam Bass Hideaway Cave, a known site for the Bone Cave harvestman. Rather-Gaping-Pit is a small feature with little known biological significance and is not monitored for karst invertebrates. The Chaos Preserve was identified by the USFWS as a potential KFA in the Bone Cave harvestman 5-year review (USFWS 2018b). Chaos Preserve is fenced and has appropriate signage to aid trespassing prevention per guidelines set in the RHCP by USFWS (SWCA et al. 2008).

Table 11. Basic Information for the Chaos Cave Preserve

Chaos Preserve Information	
Preserve Inception Year	2008
Acreage	30.0
Fence Status	Fully fenced
Sign Status	Signs posted around perimeter
Baseline Vegetation Survey Date	None
Owner	Easement- TxDOT
Gated Caves	None
Non-gated Caves	Under-the-Fence, Chaos, Poison Ivy, Rather-Gaping-Pit



Figure 13. Chaos Preserve location map.

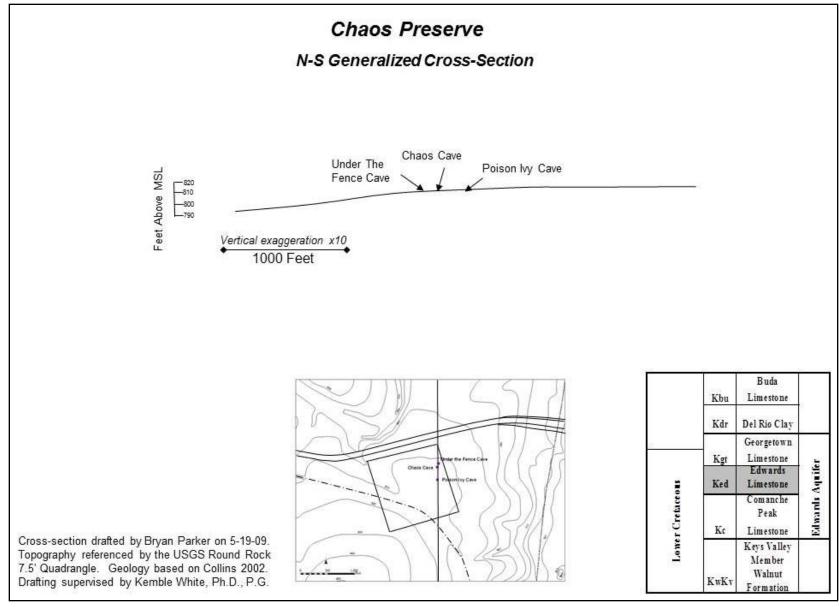


Figure 14. Geologic cross section of the Chaos Preserve.

# 2.6.2 Hydrogeology

Chaos Preserve is located entirely within the EARZ. Based on regional patterns, recharge from the property likely follows the groundwater gradient to the northeast and east toward Rattan Creek and Smith Lake, but no formal study has been conducted.

#### 2.6.3 Caves of the Chaos Preserve

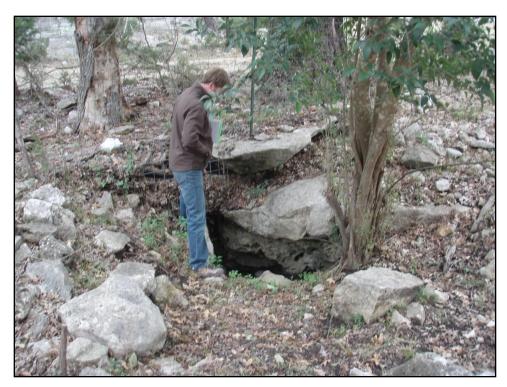
Access to the Chaos Preserve is relatively difficult; therefore, no caves are currently gated. Cave maps are included in Appendix F.

**Chaos Cave:** The Chaos Cave entrance is located within a sinkhole approximately 9 feet in diameter (Photograph 22). The entrance drops vertically for 5 feet and opens into a single room passage measuring approximately 18 feet in diameter. The open cave passage maximum depth is approximately 9 feet. This cave is not currently gated and is known to contain the Bone Cave harvestman.



Photograph 22. Chaos Cave entrance.

**Under the Fence Cave:** The Under the Fence Cave entrance is located directly beneath the fence separating the Chaos Preserve from the adjacent property (Photograph 23). The cave entrance drops vertically 5 feet and slopes downwards and south. The passage extends approximately 15 feet and terminates in a single room approximately 18 feet long by 9 feet wide. The open cave passage maximum depth is approximately 10 feet. This cave is known to contain the Bone Cave harvestman and does not have a cave gate.



Photograph 23. Under the Fence Cave entrance.

**Poison Ivy Cave:** The Poison Ivy Cave entrance measures approximately 5 feet long by 1.5 feet wide and slopes down vertically 6 feet (Photograph 24). Mapped cave extent is limited to a single room measuring approximately 18 feet long by 9 feet wide. This cave is known to contain Bone Cave harvestman and does not have a cave gate.



Photograph 24. Poison Ivy Cave entrance.

**Rather-Gaping-Pit:** No specific description or map was available for this feature. This feature is not monitored for karst biota, nor does it have a cave gate to prevent unauthorized access.

Table 12 shows documented species within the Chaos Cave Preserve.

Table 12. Species Documented from the Chaos Cave Preserve

	Species		Under the Fence Cave	Poison Ivy Cave
	Permitted S	pecies		
Texella reyesi		√	√	<b>√</b>
	Other Spo	ecies		
Crickets	Ceuthophilus cunicularis	√		<b>√</b>
Crickets	Ceuthophilus secretus	√	√	<b>√</b>
	Cicurina buwata	√		<b>√</b>
	Cicurina varians	√	√	<b>√</b>
	Tayshaneta sp.	√		
	Eperigone albula	√		
Arachnids	Agyneta sp.	√		
Arachnias	Eidmannella sp.	√		<b>√</b>
	Araneae	√	√	<b>√</b>
	Cryptachaea porteri	√	√	<b>√</b>
	Vonones sp.			<b>V</b>
	Eumesosoma sp.			√

	Species	Chaos Cave	Under the Fence Cave	Poison Ivy Cave
	Leiobunum townsendi	√	V	√
	Mite	√		
	Tick	V		
	Cambala speobia	V		
	Speodesmus bicornourus	V		
Millipedes/	Scutigeridae	V		√
Centipedes	Scolopendra sp.	V		√
	Lithobiomorpha	V		
	Oxidus gracilis			√
	Coleoptera		V	
	Batrisodes uncicornis	V		√
Beetles	Anillinus sp.	V		
	Staphylinidae	V		√
	Rhadine subterranea	V		
	Eleutherodactylus marnockii	V		√
Reptiles/	Plethodon albagula	V		
Amphibians	Scincella lateralis	V		
	Lithobates berlandieri	V		
	Perimyotis subflavus	V		
Mammals	Myotis velifer	V		
	Coragyps atratus	V		√
	Gnats			√
	Collembola	V	V	√
	Surface Silverfish	V		
	Black Ant			√
	Red Ant	V		
	Earthworm	V		√
Other	Helicodiscus sp.	√		
	Gastropod			√
	Arenivaga sp.	√		√
	Assassin Bug			√
	Diptera	√	√	√
	Dark Springtail	√		
	Isopod	√	√	√

# 2.7 Big Oak Cave Preserve

### 2.7.1 Introduction

Williamson County assumed management responsibility for the Big Oak Cave Preserve (Table 13) in 2008 from TxDOT's Texas Turnpike Authority Division. The Big Oak Preserve is limited to known Big Oak Cave extent and is the only cave currently managed by the County known to contain the Tooth Cave ground beetle (*Rhadine persephone*). TxDOT had originally agreed to biological monitoring of Big Oak Cave as a conservation measure related to the 2001 U.S. Highway (U.S.) 183A project's Environmental Impact Statement. The cave occurs within an approximately 0.5-mile-long median area between the "new" U.S. 183A and the "old" U.S. 183 facilities (also known as South Bell Boulevard); with a 225-foot maximum width within a 10-acre area (Figure 15). The cave's footprint and surface drainage area have been avoided by construction, but impervious cover exists above some subsurface drainage basin, which has reduced the cave's capacity to contribute to species recovery. TxDOT funded annual Big Oak Cave for the first four years (2004–2007) following monitoring plan approval in order to study the long-term roadway development and operation on cave species impacts.

The County has agreed to preserve and protect the natural, scenic, open space, and ecological features of Big Oak Cave, to provide funding for monitoring activities, and to report on those activities to TxDOT biannually in a contract for mitigation services between Williamson County and TxDOT dated August 26, 2008. The Big Oak Cave Preserve is not fenced but does maintain two cave gates to prevent unauthorized access to both cave entrances.

Table 13. Basic Information for the Big Oak Cave Preserve

Big Oak Cave Preserve Information				
Preserve Inception Year	2008			
Acreage	10.0			
Fence Status	None			
Sign Status	Warning signs on all cave gates			
Baseline Vegetation Survey Date	None			
Owner	Easement- TxDOT			
Gated Caves	Big Oak Cave			
Non-gated Caves	None			



Figure 15. Big Oak Cave Preserve location map.

# 2.7.2 Hydrogeology

Big Oak Cave Preserve is located within the EARZ. Based on the regional hydrologic gradient, cave recharge likely discharges to the northeast along Brushy Creek, but no formal study has been conducted.

## 2.7.3 Caves of the Big Oak Cave Preserve

Cave maps are included within Appendix G.

**Big Oak Cave:** No specific size and configuration information for this cave is available. However, Big Oak Cave has two gated entrances (east and west) leading to small, shallow single rooms that are not connected by humanly accessible passages. Photograph 25 shows the western gated entrance. A cave gate currently prevents unauthorized access to this feature.

Table 14 shows documented species within the Big Oak Cave Preserve.



Photograph 25. Big Oak Cave western entrance.

Table 14. Species Documented from the Big Oak Cave Preserve

	Species	Big Oak Cave					
	Permitted Species						
Rhadine persephone		$\checkmark$					
	Other Species						
Crickets	Ceuthophilus sp.	$\checkmark$					
	Cicurina varians	$\checkmark$					
Arachnids	Araneae	√					
	Achaearanea sp.	V					
	Cambala speobia	$\checkmark$					
Millipedes/ Centipedes	Speodesmus bicornorus	V					
Beetles	Staphylinidae	$\sqrt{}$					
Reptiles/ Amphibians	Eleutherodactylus marnockii	$\checkmark$					
	Coragyps atratus	$\checkmark$					
	Moth	$\checkmark$					
	Collembola sp.	$\checkmark$					
Other	Helicodiscus sp.	$\checkmark$					
	Assassin Bug	$\checkmark$					
	Isopod	V					

## 2.8 Priscilla's Well Karst Fauna Area

### 2.8.1 Introduction

The Priscilla's Well Preserve was the first KFA recognized by the USFWS as contributing to a listed karst invertebrate species recovery. The Priscilla's Well KFA (Table 15) is 51.5 acres and is generally located between Ronald W. Reagan Boulevard and a residential portion of the Sun City development (Figure 16). Priscilla's Well Cave is documented to contain both the Bone Cave harvestman and Dragonfly Cave mold beetle; Priscilla's Cave is documented to have the Bone Cave harvestman (Verdoorn 1994), USFWS (2018b) does not list Yearwood Gold Mine as a Bone Cave harvestman locality. The KFA encompasses a 13.4-acre area proposed as a preserve in the 1994 management plan for Sun City Georgetown (Verdoorn 1994). Priscilla's Well Cave was biologically monitored for 5 years between 1995 and 2000, and Batrisodes cryptotexanus was found on nine out of 16 sampling occasions. Priscilla's Cave was not biologically monitored beyond the initial Sun City investigation. Batrisodes cryptotexanus may also be found within Priscilla's Cave with continued monitoring, given the two caves' proximity and similarity. The Priscilla's Well KFA is generally in "natural" condition, consisting of a mixed woodland/grassland mosaic. Cattle grazing at this location has officially ceased; however, few neighboring animals do make it onto the Priscilla's Well KFA through fence breaks. Fencing and signage are placed to restrict cave and KFA access. Cave gates are present on both Priscilla's Well Cave and Priscilla's Cave. Yearwood Gold Mine is not currently monitored or gated.

The proximity of Priscilla's Well KFA to Ronald Reagan Boulevard has prompted concern that a spill or other catastrophic event adjacent to the preserve could negatively impact the cave ecosystem contained within the property. However, the road itself is down gradient from both caves and guardrails have been installed to prevent vehicles carrying fuel (or other contaminants) from accidentally crashing into Priscilla's Well KFA; therefore, impact from such an event is unlikely. Photograph 26 shows the following three existing best management practices along Ronald Reagan Boulevard adjacent to Priscilla's Well KFA: KFA fence, rock gabions to slow stormwater moving off Ronald Reagan Boulevard, and guardrails to help prevent vehicular accidents from negatively impacting the Priscilla's Well KFA.

Table 15. Basic Information for the Priscilla's Well KFA

Priscilla's Well KFA Information	
Preserve Inception Year	2008
Acreage	51.5
Fence Status	Fully fenced
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	2007
Owner	Williamson County
Gated Caves	Priscilla's Well, Priscilla's
Non-gated Caves	Yearwood Gold Mine

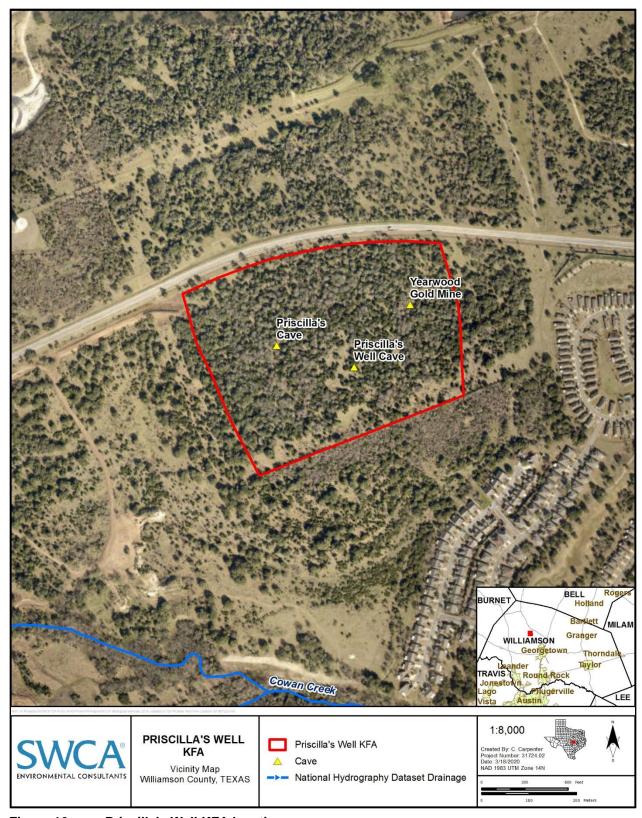


Figure 16. Priscilla's Well KFA location map.



Photograph 26. Three visible best management practices at the Priscilla's Well KFA: roadway guardrails (left), rock gabions (center), and preserve fence (right).

## 2.8.2 Hydrogeology

Priscilla's Well KFA encompasses a broad, flat hilltop with a highest elevation of slightly more than 940 feet amsl. Both Priscilla's Cave and Priscilla's Well Cave entrances lie within the 940-foot contour line. None of the caves nor karst features within the KFA likely drain a significant area due to the lack of relief from hilltop placement. The features generally drain a few hundred square feet up-gradient from cave entrances.

The Priscilla's Well KFA is underlain by the Edwards Formation, which is estimated to range from 120 to 200 feet in regional thickness (Collins 2002; Verdoorn 1994; Senger et al. 1990). There are identifiable preferential development horizons for karst features within the Edwards Formation that correspond with less-resistant limestone beds even though the Edwards Formation has not been stratigraphically subdivided north of Austin. Hundreds of karst feature analyses on more than 5,000 acres surrounding the Priscilla's Well KFA (Verdoorn 1994) found that cave development was largely confined to three distinct solution zones at the top, middle, and base of the Edwards Formation. The hilltop containing the Priscilla's Well KFA is capped by an outcrop of the upper solution zone that is isolated by erosion along the drainage divide between Cowan and Berry creeks. All known karst features within the KFA are confined within that zone, which appears to be approximately 20 feet thick.

The Edwards Formation also hosts nearly impermeable limestone and chert alternating beds that serve as barriers to downward-moving groundwater, creating wet-weather seeps where lateral groundwater movement is expressed as hillside seeps, which only flow after heavy rain. Alternating zones of dissolution and impermeable beds constrain most mapped caves vertical extent in the area, preventing vertical cave formation. Vertical shaft passages are nearly absent in Williamson County except in caves adjacent to faults. No faults are known to occur within the Priscilla's Well KFA. All caves within the

Priscilla's Well KFA are formed predominantly along bedding planes horizontally with relatively minor vertical expression at their entrances. Surface water entering the caves and karst features within the Priscilla's Well KFA is incorporated with a perched groundwater system where short residence time water drained by gravity radially away from the hilltop to discharge along the hillside. The groundwater flows downward through the upper Edwards Formation solution zone containing the macroscopic karst features until it intersects an impermeable layer that slows progress until exiting the hillside. This interpretation is strongly supported by the presence of several wet-weather seeps at the 887-foot contour line. These seeps were observed flowing following unusually rainy weather in summer 2007 and were not observed during dry periods in 2008.

### 2.8.3 Caves of the Priscilla's Well KFA

Priscilla's Cave, Priscilla's Well Cave, and Yearwood Gold Mine are small voids reflecting the broader fabric and mesocavernous nature of the local karst. The true measure of troglobite habitat within the Priscilla's Well KFA is more accurately represented by karst feature distribution. Cave maps are included within Appendix H.

**Priscilla's Well Cave:** Priscilla's Well Cave entrance drops 4.5 feet to a ledge-like landing that drops again to 15 feet deep. The cave interior is 19.9 feet high at its highest point and has an irregular but generally oblong shape. The cave measures 68.5 feet long. Biological surveys conducted between 1995 and 2000 found *Batrisodes cryptotexanus*. SWCA documented the Bone Cave harvestman in 2017. Further investigation will likely result in other troglobitic species detection. A cave gate currently prevents unauthorized access to this feature.

**Priscilla's Cave:** Priscilla's Cave has two narrow, vertical entrances that drop down into the main cavern. The larger entrance drops 10.5 feet and the second entrance drops 8.7 feet. The interior is a low, wide circular room, measuring approximately 15 to 20 feet in diameter. Priscilla's Cave was not biologically monitored beyond the initial Sun City investigation and—given the proximity and similarity of the two caves—*Batrisodes cryptotexanus* may be found with continued monitoring. An SWCA biospeleologist documented the Bone Cave harvestman on September 8, 2007, within Priscilla's Cave. A cave gate currently prevents unauthorized access to this feature.

**Yearwood Gold Mine:** Yearwood Gold Mine appears as a circular open pit approximately 5.0 feet wide and drops approximately 3.8 feet down. The bottom of the pit is filled with old trash. Lateral extent is primarily to the north and accessible portions of the cave are approximately 47 feet deep. USFWS (2018a, 2018b) does not list Yearwood Gold Mine as a known locality for either the Bone Cave harvestman or the *Batrisodes cryptotexanus*. This feature is not currently gated and is not currently surveyed for karst invertebrates.

Table 16 shows documented species within the Priscilla's Well KFA.

Table 16. Species Documented from the Priscilla's Well KFA

Sp	ecies	Priscilla's Cave	Priscilla's Well Cave	
Permitted Species				
Texella reyesi		V	V	
Batrisodes cryptotexanus	Batrisodes cryptotexanus		V	
	Other	Species		
Cuinkata	Ceuthophilus secretus	√	$\checkmark$	
Crickets	Ceuthophilus cunicularis	√	$\checkmark$	
	Cicurina varians	√	$\checkmark$	
	Cicurina vibora	√	$\checkmark$	
	Tayshaneta sp.		√	
	Cryptachaea porteri	<b>√</b>	√	
	Anipistula sp.		V	
Arachnids	Araneae	<b>√</b>	√	
	Eidmannella sp.		V	
	Leiobunum townsendi		$\sqrt{}$	
	Aphrastochthonius sp.		$\sqrt{}$	
	Pseudosinella sp.		$\sqrt{}$	
	Pseudouroctonus reddelli	V		
	Scutigeridae	√	$\sqrt{}$	
Millimedee/ Continuedee	Lithobiidae		V	
Millipedes/ Centipedes	Cambala speobia	V	√	
	Scolopendra sp.	√		
D. eller	Rhadine noctivaga		V	
Beetles	Staphylinidae		$\sqrt{}$	
Doubles / Amarkibians	Eleutherodactylus marnockii	V		
Reptiles/ Amphibians	Incilius nebulifer		√	
	Perimyotis subflavus	√		
Mammals	Myotis velifer	√		
	Collembola	V	V	
	Arenivaga sp.	V	V	
	Red Ant	√		
Other	Assassin Bug	√		
	Earthworm		√	
	Isopod	V	√	
	Mosquito		√	
	Gnat		√	
	Helicodiscus sp.		V	

## 2.9 Woodland Park Cave Preserve

### 2.9.1 Introduction

The WCCF agreed to take over management of Duckworth Bat Cave and Cat Cave in 2012 due to a preenforcement settlement agreement between the USFWS and Mr. Jimmy Jacobs (President of Shel-Jenn, Incorporated). Shel-Jenn, Inc. dedicated two conservation areas located in the Woodland Park subdivision and called them the Woodland Park Cave Preserve, approximately 2.3 miles northwest from Heritage Oaks (Table 17, Figure 17). The Cat Cave conservation area is 4.6 acres and contains the cave's entire surface drainage area. The Duckworth Bat Cave conservation area is 5.6 acres and contains the cave's entire surface drainage area. Both caves are known to contain the Bone Cave harvestman and both conservation areas contain the majority of the cricket foraging areas proposed by Taylor et al. (2005). Cave gates prevent unauthorized access to Cat Cave and Duckworth Bat Cave while fencing is not currently present.

Table 17. Basic Information for the Woodland Park Cave Preserve

Woodland Park Cave Preserve Information	
Preserve Inception Year	2012
Acreage	10.2
Fence Status	None
Sign Status	Warning signs on all cave gates
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Cat, Duckworth Bat
Non-gated Caves	None

# 2.9.2 Hydrogeology

Both conservation areas are located within the EARZ. Based on informal studies conducted for the previous landowner, site-specific geology indicates that Duckworth Bat Cave and Cat Cave may be located within the drainage basin for Cowan Spring, which is known to be occupied by the Georgetown salamander (Figure 18).



Figure 17. Woodland Park location map.

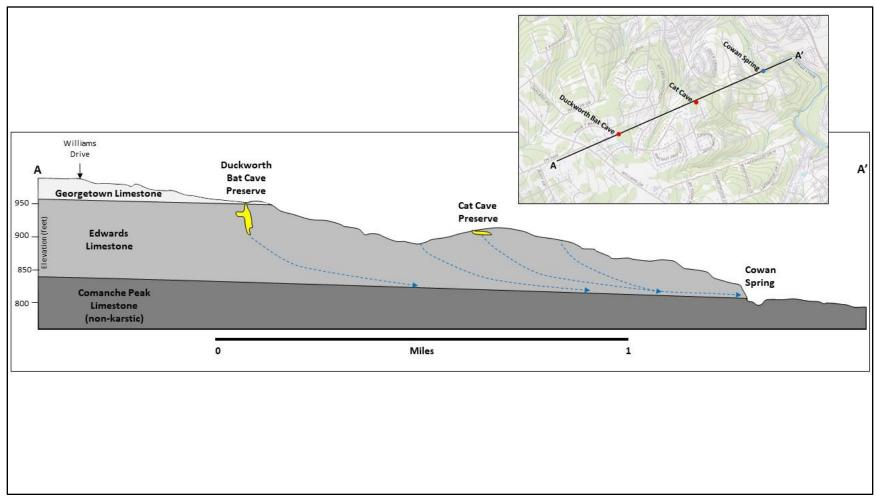


Figure 18. Cat and Duckworth Bat Caves hydrogeologic setting with local springs.

### 2.9.3 Caves of the Woodland Park Cave Preserve

Cat Cave and Duckworth Bat Cave maps are included in Appendix I.

**Cat Cave:** This cave description is paraphrased from Mike Warton and Associates (1999). A cedar elm tree canopy hangs over the entrance to the cave (Photograph 27). The portal is approximately 8 feet wide, rimmed with solid rock, and is located in a surface sink depression that measures approximately 30 feet across. The entrance is in-filled with naturally eroded materials. The entrance room measures approximately 40 by 30 feet and gradually slopes to the west. The ceiling height ranges from 1 to 4 feet. Several more passages and rooms exist beyond this point. A gate currently prevents unauthorized access and the Bone Cave harvestman is known from this feature.



Photograph 27. Cat Cave entrance.

**Duckworth Bat Cave:** This cave description is paraphrased from Mike Warton and Associates (1999). The entrance to the cave is located in a surface sinkhole measuring approximately 10 feet in diameter and is formed along a rock joint trending N20W. The portal is a rock-rimmed vertical shaft approximately 6 by 4 feet. After a 27-foot drop to the floor, the room below extends in all directions with ceiling heights between 2 and 6 feet. After excavation, the cave measured at 528.5 feet long and 51.3 feet deep (Photographs 28 and 29). A gate currently prevents unauthorized access and the Bone Cave harvestman is known from this feature.

Table 18 shows documented species within the Woodland Park Cave Preserve.



Photograph 28. Duckworth Bat Cave entrance.



Photograph 29. Duckworth Bat Cave entrance pit.

 Table 18.
 Species Documented from the Woodland Park Preserve

	Species	Duckworth Bat Cave	Cat Cave
		Permitted Species	
Texella reyesi		√	
Batrisodes cryptotes	xanus	V	
• •		Other Species	
Ordelada	Ceuthophilus secretus	√	$\checkmark$
Crickets	Ceuthophilus cunicularis	√	√
	Cicurina varians	√	√
	Cicurina vibora	√	√
	Cryptachaea porteri	√	$\checkmark$
	Eidmannella sp.	√	$\checkmark$
	Agyneta sp.		$\sqrt{}$
Arachnids	Araneae	$\sqrt{}$	$\sqrt{}$
Aracillius	Tayshaneta sp.	$\sqrt{}$	$\sqrt{}$
	Anipistula sp.	$\checkmark$	
	Leiobunum townsendi	V	√
	Pseudoscorpion		√
	Aphrastochthonius sp.		√
	Pseudouroctonus reddelli	√	√
	Tick		$\checkmark$
	Cambala speobia	√	√
	Speodesmus bicornorus	√	√
Millipedes/	Scutigeridae	√	√
Centipedes	Lithobiomorpha	√	√ 
	Geophilomorpha		√
	Scolopendra sp.	√	
	Anillinus sp.		√
Beetles	Rhadine noctivaga	V	
	Staphylinidae	V	√
	Rana berlandieri	V	√
Reptiles/	Heterodon platirhinos	√	
Amphibians	Thamnophis sp.	√	
	Incilius nebulifer		√ 
	Eleutherodactylus marnockii	V	V
Mammals	Perimyotis subflavus	V	,
	Myotis valliceps	V	V
	Arenivaga sp.	V	√ 
	Gnat	√	√ 
	Fly	√ 	<b>√</b>
	Collembola	√	√ 
Other	Moth		√ 
	Earthworm	√	√ 
	Flea		√ 
	Assassin Bug	√ 1	√ 
	Isopod	√ 	√
	Helicodiscus sp.	V	

## 2.10 Karankawa Cave Karst Fauna Area

### 2.10.1 Introduction

Williamson County closed on the acquisition of the Karankawa Cave KFA in 2012, as approved by the USFWS. The 61.7-acre Karankawa Cave KFA (Table 19) is located south of SH 195 and approximately 7 miles northwest from the City of Georgetown (Figure 19).

Vegetation within the Karankawa Cave KFA consists of plateau live oak-juniper savanna on gently rolling uplands generally draining westward. A minor upland tributary to Berry Creek runs through the middle of the KFA, from northeast to southwest, and the drainage orientation is controlled by a fault that has heavily influenced karst development. The Karankawa Cave KFA boundaries accommodate a biological connection between subsurface mesocaverns and surface flora and fauna within the KFA to the Berry Creek floodplain. The Karankawa Cave KFA is within the northern BFZ and within the Edwards Aquifer's northern segment recharge zone.

The Karankawa Cave KFA contains eight caves (see Figure 19) and two endangered karst invertebrate species, along with at least six "additional species" addressed in the RHCP (SWCA et al. 2008). The Karankawa Cave KFA and associated caves were partially documented and surveyed for biota in 1994 for the Sun City, Georgetown take avoidance plan. Karankawa and War Party Caves are known to contain the Bone Cave harvestman and the Dragonfly Cave mold beetle; while Polaris and Pemmican Caves are known to contain only the Bone Cave harvestman. *Batrisodes cryptotexanus* may yet be detected in Pemmican and Polaris Caves due the presence of other troglobites.

Fencing currently separates the Karankawa Cave KFA from Ronald Reagan Boulevard, but does not otherwise encircle the entire preserve. Developmental encroachment has continued and the need to separate the eastern and western preserve boundaries has increased. Cave gates currently prevent unauthorized access to Angostura and Pemmican Caves; whereas Quahadi Cave, Karankawa, Polaris, Quahadi Sink, Snake Dancer, and War Party Caves are not gated.

Table 19. Basic Information for the Karankawa Cave KFA

Karankawa Cave KFA Information	
Preserve Inception Year	2012
Acreage	61.7
Fence Status	Northwest boundary fenced along Ronald Reagan Blvd
Sign Status	None
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Pemmican, Angostura
Non-gated Caves	Quahadi Cave, Karankawa, Polaris, Quahadi Sink, Snake Dancer, War Party

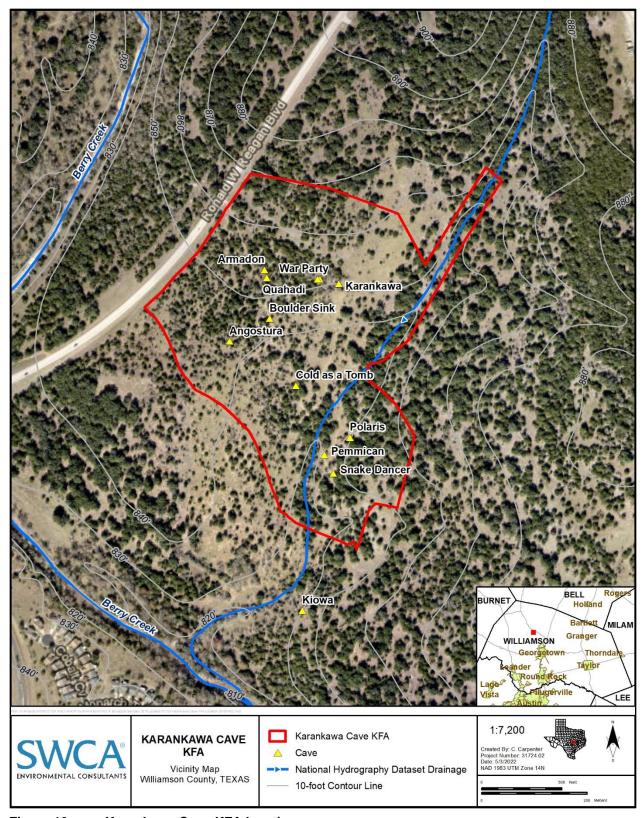


Figure 19. Karankawa Cave KFA location map.

## 2.10.2 Hydrogeology

The Karankawa Cave KFA occupies a relatively flat upland area that drains primarily south and west into an unnamed tributary to Berry Creek. Total relief is approximately 40 feet and ranges from approximately 830 to 870 feet amsl. The easement is entirely underlain by Edwards limestone, which is up to 120 feet thick in the area (Collins 2002; Senger et al. 1990).

The Karankawa Cave KFA is within the EARZ northern segment and groundwater recharge primarily occurs in areas where the Edwards Group and upper confining units are exposed at the surface. The tributary location and path appears controlled by the previously mentioned fault. Mapped contact elevations between the Edwards, Comanche Peak and Georgetown formations indicate the fault creates an approximately 15-foot displacement (Figure 20). Cave formation was likely driven by fault-induced, fracture-enhanced permeability. Caves within the Karankawa Cave KFA show fractures related to this fault influence the morphology. Pemmican, Polaris, and Snake Dancer Caves are elongated along fractures that are parallel or sub-parallel to the fault; while Karankawa, War Party, and Angostura caves are influenced by conjugate faults that are roughly perpendicular to the fault. Fracture-driven solutional enlargement has likely enhanced mesocavern connectivity along and across the fault plane.

Rainfall that is not lost through runoff or evapotranspiration likely becomes groundwater by infiltrating through the permeable Edwards limestone. The on-site creek bed is likely an efficient area of focused recharge. Based on the available information, groundwater within the KFA likely flows northeast to southwest mirroring the trend of the caves in the northern cluster. As it approaches the fault, the increasing abundance of vertical fractures likely provides numerous avenues for vertical infiltration to the water table that occurs at just above 800 feet, according to nearby well records.

## 2.10.3 Caves of the Karankawa Cave Karst Fauna Area

Cave maps are included in Appendix J.

**Angostura Cave:** The entrance to Angostura Cave drops 4 feet to a ledge-like landing that slopes downward into the cave. The interior is a low, wide irregular room measuring approximately 20 by 15 feet by 2 feet high with an uneven floor and nodular ceiling. The floor is soil and clay with breakdown blocks and boulders. The cave seems to have formed by the collapse of a deeper void network and may be a strong indication of mesocavern habitat related to other caves in the northern cluster. A cave gate is currently installed on Angostura Cave.

**Cold as a Tomb:** The entrance to Cold as a Tomb is surrounded by excavated boulders and large chunks of bedrock. There is an immediate 9 foot drop that stairsteps down to the cave floor. The cave is a single chamber approximately 18 feet long and very exposed to the surface climate. Several potential dig leads occur within Cold as a Tomb and it is neither gated, nor is it surveyed for karst invertebrates.

**Quahadi Cave<sup>4</sup>:** Quahadi Cave is a small, shallow cave formed along a bedding plane and measures approximately 10 by 15 feet, with at least two humanly inaccessible extensions into the mesocavern matrix and seems to have formed by a deeper void network collapse. This cave is currently not gated.

**Karankawa Cave:** Karankawa Cave is the largest and deepest cave within the Karankawa Cave KFA and is approximately 92 feet long by 40 feet wide and 21.6 feet deep at its lowest point. Passage proceeds

<sup>4</sup> Erroneously called Armadon Cave in all previous Preserve Description reports. James Reddell has determined the cave at this location is actually Quahadi Cave, not Armadon Cave. Not that "Armadon Cave" is still included in Appendix J but has a strike through the title with "Quahadi Cave" added below the old title. This modification is made to help prevent confusion for the reader who may be familiar with the old cave name.

east and then south from the entrance in an arc surrounding a central collapse zone. The WCCF installed a cave gate on Karankawa Cave in 2020. Both the Bone Cave harvestman and the Dragonfly Cave mold beetle are documented from this location.

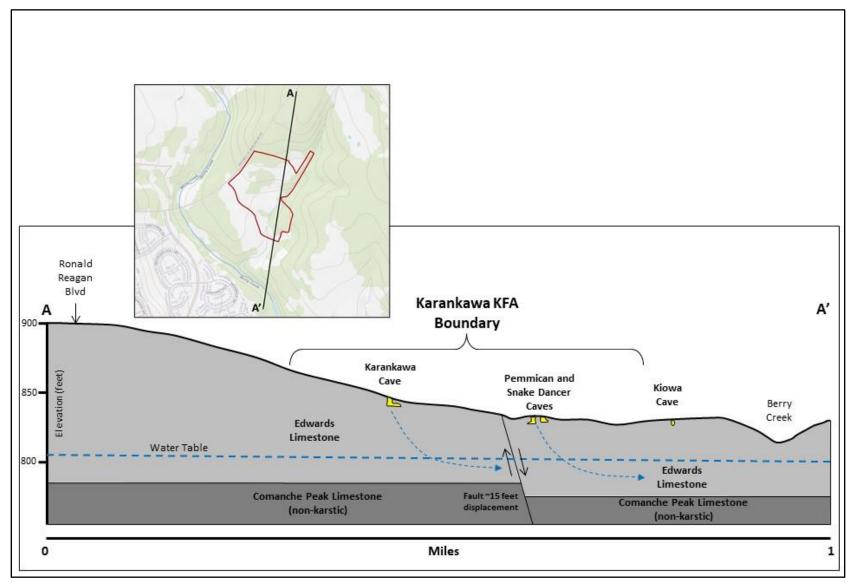


Figure 20. Karankawa Cave KFA hydrogeology.

**Pemmican Cave:** Pemmican Cave entrance measures approximately 2 feet long by 1.5 feet wide in solid bedrock, and drops about 10 feet to a floor lined with sediment and small rocks. The main cave extends northeast from the entrance and is a roughly rectangular room measuring approximately 30 feet wide by 50 feet long by up to 4 feet high. An opening to the south becomes too low for human exploration after a few feet. A breakdown-floored alcove in the main room's southeast side gradually becomes too narrow to access. The main room terminates in a narrow passage formed along a joint trending N18E. Near the end of the cave, it is possible to descend through breakdown to enter a low descending lower-level passage that extends back toward the entrance for about 25 feet before splitting and becoming too small, which is the deepest cave extent at 17.3 feet below the entrance. Pulverulite is exposed in some places and speleothems are abundant in several areas. Polaris, Pemmican, and Snake Dancer Caves are all formed within the fault's damage zone and are likely interconnected through mesocaverns. A cave gate is currently installed on Pemmican Cave and the Bone Cave harvestman is documented from this location.

**Polaris Cave:** Polaris Cave consists of a low, broad chamber formed along a bedding plane with a footprint approximately 50 feet in diameter. Speleothems in the chamber south from the entrance are aligned with fractures parallel to the fault, which passes approximately 100 feet northwest. No cave gate is on this feature, and the Bone Cave harvestman is documented from this location.

**Quahadi Sink<sup>5</sup>:** Quahadi Sink consists of a low, broad chamber formed along a bedding plane with a footprint measuring approximately 30 feet in diameter. The cave was likely formed by a deeper void network collapse, and there is a strong mesocavern habitat indication related to other caves in the northern cluster. No cave gate is on Quahadi Sink.

**Snake Dancer Cave:** The entrance to Snake Dancer Cave measures approximately 6 feet wide by 8 feet long by 4.5 feet deep. A 6-foot-wide crawlway leads into an irregular chamber measuring approximately 45 feet long and between 15 and 30 feet wide. The rear cave extent slopes down at about a 45-degree angle to the deepest point at 9 feet below the entrance. Two passages at the end of the room extend for a few feet before becoming too low to continue. One of these passages is formed along a joint trending N18E and investigators detected airflow. Several large breakdown blocks are present in the main room. The cave contains numerous small speleothems and several massive flowstone deposits. The floor consists largely of black soil and clay. Snake Dancer Cave is not currently gated.

War Party Cave: War Party Cave consists of a low, broad chamber formed along a bedding plane with a footprint measuring approximately 60 feet in diameter. The cave was likely formed by a deeper void network collapse and there is a strong mesocavern habitat indication related to other caves in the northern cluster. The cave drains to a bedrock fracture running perpendicular to the fault to the southeast. The cave's overall morphology is elongated, and the fracture indicates that War Party may have been formed by the collapse of a deeper, fracture-controlled groundwater conduit. That flow would likely have been intercepted by vertical conduits as it approached the fault, which delivered the groundwater to the aquifer base level. Speleothems in the chamber's south end are aligned with fractures parallel to the fault, which passes approximately 100 feet northwest. A cave gate is not currently installed on War Party Cave and both the Bone Cave harvestman and the Dragonfly Cave mold beetle are documented from this location.

Table 20 shows documented species within the Karankawa Cave KFA.

<sup>&</sup>lt;sup>5</sup> Erroneously called Quahadi Cave in all previous Preserve Description reports. James Reddell has determined the feature at this location is actually Quahadi Sink, not Quahadi Cave. Not that "Quahadi Cave" is still included in Appendix J but has a strike through the title with "Quahadi Sink" added below the old title. This modification is made to help prevent confusion for the reader who may be familiar with the old cave name.

Table 20. Species Documented from the Karankawa Cave KFA

;	Species	Angostura	Quahadi Cave	Karankawa	Pemmican	Polaris	Quahadi Sink	Snake Dancer	War Party
			Permitted Sp	ecies					
Batrisodes cryptotexanus				√					√
Texella reyesi				√	√	√			√
			Other Spec	cies					
Crickets	Ceuthophilus secretus	√	V	√	√	√	√	√	√
Crickets	Ceuthophilus cunicularis			√					√
	Cicurina vibora			√	√	√		√	√
	Cicurina varians		√	√	√	√	√	<b>√</b>	√
	Eidmannella sp.			√	√	√			√
	Araneae				√				
	Agyneta sp.				√				√
A wa a la wi a la	Anapistula sp.			√		√			√
Arachnids	Achaearanea sp.				√	√			
	Tayshaneta sp.			√	√				√
	Cryptachaea porteri	√	√	√	√		√		√
	Leiobunum townsendi			√		V			
	Pseudoscorpion								√
	Pseudouroctonus reddelli		√	√	√	√	√		√
	Speodesmus bicornourus			√	√	√		V	√
	Cambala speobia		√	√	√	√	√	<b>√</b>	√
Million de el Ocudor de e	Oxidus gracilis				√				
Millipedes/ Centipedes	Scolopendra sp.				√			V	√
	Lithobiidae		√						√
	Scutigeridae				√	√	√	V	
	Coleoptera (Surface Beetles)				√	√		<b>V</b>	
	Batrisodes uncicornis			√	√			√	√
	Beetle larva				√				
Beetles	Tachyini sp.			√	√			√	
	Staphylinidae		√	√	√	√	√	√	√
	Dermestidae			√					
	Rhadine noctivaga			√	<b>√</b>	<b>√</b>			√

5	Species	Angostura	Quahadi Cave	Karankawa	Pemmican	Polaris	Quahadi Sink	Snake Dancer	War Party
	Crotalus atrox		<b>√</b>				√		
Dentiles/Amphibians	Plethodon albagula					√			
Reptiles/ Amphibians	Incilius nebulifer			√	<b>√</b>				√
	Eleutherodactylus marnockii		V		√	√		√	<b>√</b>
	Procyon lotor				√				<b>√</b>
	Didelphis virginiana							√	
Mammals	Sylvilagus floridanus					√			
	Perimyotis subflavus		V	√					
	Myotis velifer		V	√				√	
	Texoreddellia sp.		√	√	√	√			√
	Campodeidae				√				√
	Arenivaga sp.	√			√			√	√
	Isopod		V	√	√			√	
	Surface Silverfish	√			√				1
	Collembola	√	V	√	√	√	√	√	√
	Assassin Bug		√	√	√	√		√	√
	Hemiptera								√
	Diptera				√				
Other	Gnat		V	√	√	√			
	Flea		V						
	Mite			√	√	√	√	√	
	Red Ant				V	√			
	Helicodiscus sp.			√	√	√			<b>V</b>
	Surface Snail			√		√			
	Moth	√	√	√	V			√	V
	Mosquito	√		√		√	√		√
	Proscoptera						√		
	Annelid		V	√	√				

### 2.11 Coffin Cave Preserve

#### 2.11.1 Introduction

Coffin Cave has long been one of the most notable caves in Central Texas. Written descriptions go back to at least 1958 and the original Texas Cave Survey (Widener 1958). Since 1963—when cave explorers from Southwestern University first mapped Coffin Cave—it has been known as one of the deepest and most extensive caves in Williamson County. The somewhat ominous name of the cave stemmed from the observation that the vertical entrance shaft is roughly coffin-shaped in plan view. Adding to the mystique of the cave is that its location had been lost to the caving community by the time of the listing process for the Travis and Williamson County karst invertebrates in the early 1990s. The location had not been lost to Mr. Marvin Andres, who owned the cave for more than 50 years and kept access generally restricted. Williamson County purchased the cave from Mr. Andres' heirs in 2014 and established the approximately 39.4-acre Coffin Cave Preserve (Table 21, Figure 21).

Fencing is erected across the entire Coffin Cave Preserve and current warning signs aid in trespassing prevention. A steel "A-frame" structure was erected across the Coffin Cave entrance in December 2016 to facilitate ingress/egress for biota monitoring and full cave gate installation was completed in 2017 (Photograph 30).

Table 21. Basic Information for the Coffin Cave Preserve

Coffin Cave Preserve Information	
Preserve Inception Year	2014
Acreage	39.4
Fence Status	Fully fenced
Sign Status	Signs posted around perimeter
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Coffin
Non-gated Caves	None



Figure 21. Location map for the Coffin Cave Preserve.



Photograph 30. Cave gate being used for the first time (2017) to lower biologists into Coffin Cave.

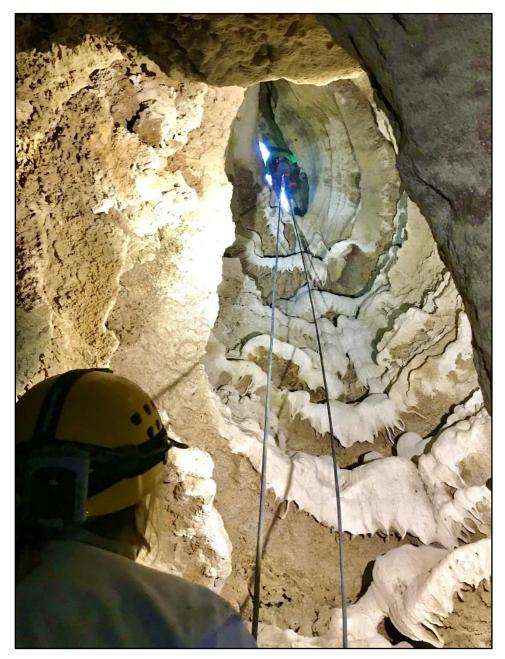
## 2.11.2 Hydrogeology

Coffin Cave is a highly efficient aquifer recharge feature whose entrance is immediately adjacent to an ephemeral surface drainage channel. Coffin Cave Preserve is mostly atop the Georgetown Formation even though the entire property is within the EARZ. The top of the Edwards Formation is only exposed on the immediate area around the cave entrance and along the Coffin Cave Preserve's lowest lying portions (along the drainage channel adjacent to the cave entrance). Runoff predominates over recharge on the less-permeable Georgetown limestone during rain events. Water is effectively routed to the Edwards outcrop where it enters Coffin Cave. The cave's surface drainage basin (approximately 58 acres) is quite large compared to the average Edwards Formation cave. Some of the original drainage basin may have been removed by the quarry immediately west from the Coffin Cave Preserve (see Figure 21). The entirety of the drainage basin of Coffin Cave could not be included within the conservation area due to the basin's large size.

Coffin Cave's other notable hydrological condition relates to its stratigraphic penetration through the Edwards Aquifer's upper half. Surface runoff is delivered almost to the aquifer base level in a matter of minutes during heavy rainfall events. The cave entrance is a solution-enlarged fracture (trending at approximately 125 degrees) measuring 7 feet long by 2 feet wide. The entrance shaft drops approximately 45 feet from its surface expression. Extensive lateral passage continues from the base of the entrance pit to the southeast and north before reaching approximately 60 feet deep.

The Edwards limestone contains three distinct zones with regards to hardness and bedrock competency: an upper hard layer, a middle softer layer, and a lower hard layer. The Coffin Cave map produced by ZARA Environmental ([ZARA] 2010) seems to show that the cave morphology evolved in response to this stratified heterogeneity within the Edwards Formation. The profile of the cave shows that the upper approximately 42.6 feet of the cave comprises a vertical shaft formed along a prominent bedrock fracture trending from the

northwest to the southeast (Photograph 31). Cave development was restricted to the fracture plane within this zone. Cave morphology is predominantly lateral where cave development followed the softer beds within the Edwards Formation below this zone at between 42.6 and 55.7 feet (Figure 22).



Photograph 31. The Coffin Cave entrance is a vertical shaft dropping into the Edwards Formation from the contact with the overlying Georgetown Formation.

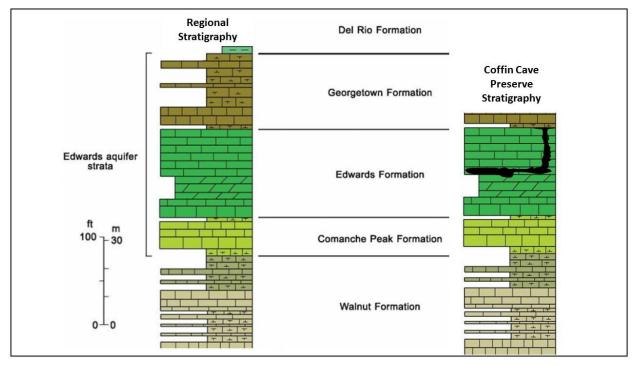


Figure 22. Coffin Cave is roughly formed in the Edwards Formation's upper half.

#### 2.11.3 Caves of the Coffin Cave Preserve

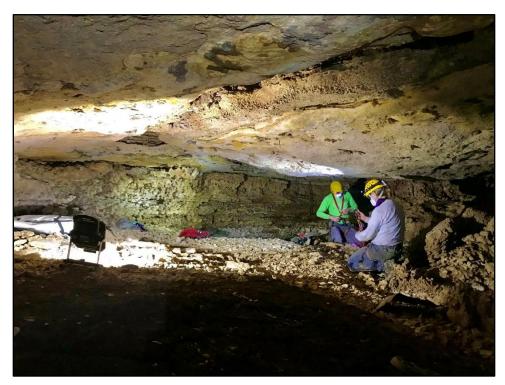
Cave map is included within Appendix K.

**Coffin Cave:** Coffin Cave is the only known cave within the Coffin Cave Preserve. Coffin Cave is perhaps best known as the source type locality for the endangered Coffin Cave mold beetle (USFWS 1994b). Subsequent taxonomic work has demonstrated that this was a misnomer, however, as the troglobitic mold beetle from this cave is now known to belong to *Batrisodes cryptotexanus*, the first diagnostic specimen of which came from Dragonfly Cave in Sun City Georgetown. Chandler et al. (2009) proposed new common names for both species: Inner Space Caverns mold beetle for *B. texanus* and Dragonfly Cave mold beetle for *B. cryptotexanus*. Table 22 summarizes cave fauna found by ZARA (2010) and WCCF-sponsored karst biota surveys. The cave is known to contain historical cave graffiti and a nearly full bear skeleton. Photograph 32 depicts the interior of Coffin Cave, immediately adjacent to the vertical drop.

Table 22. Species Documented from the Coffin Cave Preserve

	Coffin Cave				
	Permitted Species				
Batrisodes cryptotexanus		√			
Texella reyesi	√				
Other Species					
Crickets	Ceuthophilus cunicularis	√			
	Ceuthophilus secretus	$\sqrt{}$			

	Species	Coffin Cave
	Cicurina vibora	V
	Tayshaneta sp.	√
	Cicurina varians	√
Arachnids	Cryptachaea porteri	V
	Eumesosoma roeweri	√
	Tartarocreagris infernalis	V
	Eidmannella pallida	V
	Scolopendra sp.	V
Millipedes/ Centipedes	Speodesmus bicornourus	√
	Cambala speobia	√
	Coleoptera	V
	Carabidae	V
Beetles	Rhadine noctivaga	V
	Staphylinidae	√
	Ptomaphagus cavernicola	√
Mammals	Procyon lotor	V
wammais	Perimyotis subflavus	V
	Lithobates berlandieri	V
	Earthworm	V
Other	Collembola	√
Other	Annelid	V
	Earwig	V
	Helicodiscus eigenmanni	V



Photograph 32. Coffin Cave entrance immediately adjacent to the vertical drop.

## 2.12 Beck Commons Preserve

### 2.12.1 Introduction

The Beck Commons Preserve is a vegetated 4.2 acre tract completely surrounded by development. There is a large apartment complex immediately northwest of the Beck Commons Preserve and commercial development on all other sides. Beck Sewer Cave continued to function as a sewer until around 1994 when local speleologist Mike Warton conducted a trip to the cave and noted the presence of pools of foul water with maggots. WCCF acquired Beck Commons Preserve in 2014.

Written descriptions for Beck Sewer Cave and Beck Trash Cave go back to at least 1958 and the original Texas Cave Survey (Widener 1958). The Beck Sewer Cave name stems from the fact that it was fitted to operate essentially as a septic tank for a ranch house associated with the Beck Ranch operation in 1954. Most land surrounding the Beck Commons Preserve (Table 23) was part of the historic Beck Ranch (Figure 23). Beck Sewer Cave was made accessible to researchers including James Reddell (Texas Memorial Museum) and his mentor Robert W. Mitchell in January 1964. At that time, the researchers made observations as to the cave's general size and orientation; noted guano deposits from a former bat colony; and made a biological collection including blind spiders, harvestmen (almost certainly the Bone Cave harvestman), and beetles. Beck Sewer Cave remains an opportunity for the study of excess nutrient input on troglobitic ecosystems. The following quote is included in the Texas Speleological Survey report from that trip:

The cave once documented the largest population of *Rhadine* in the state. Literally thousands were observed in all parts of the cave and some were seen eating cricket eggs.

Notable historical graffiti is located in the dropdown to the lowest room (Photograph 33) and depicts the signature of E.O. Beck from December of 1941—just a few weeks after the Pearl Harbor attacks that brought the United States into World War II. Local lore has it that the caves of Beck Ranch had been explored as potential bomb shelters during the Cold War; perhaps that idea had an earlier origin.

The entirety of this preserve is fenced and appropriate signage has been placed on the fence. A cave gate is atop Beck Sewer Cave and Beck Trash Cave.

Table 23. Basic Information for the Beck Commons Preserve

Beck Commons Preserve Information	
Preserve Inception Year	2014
Acreage	4.2
Fence Status	Fully fenced
Sign Status	Warning signs on all cave gates and on fencing
Baseline Vegetation Survey Date	None
Owner	Williamson County
Gated Caves	Beck Sewer, Beck Trash
Non-gated Caves	None

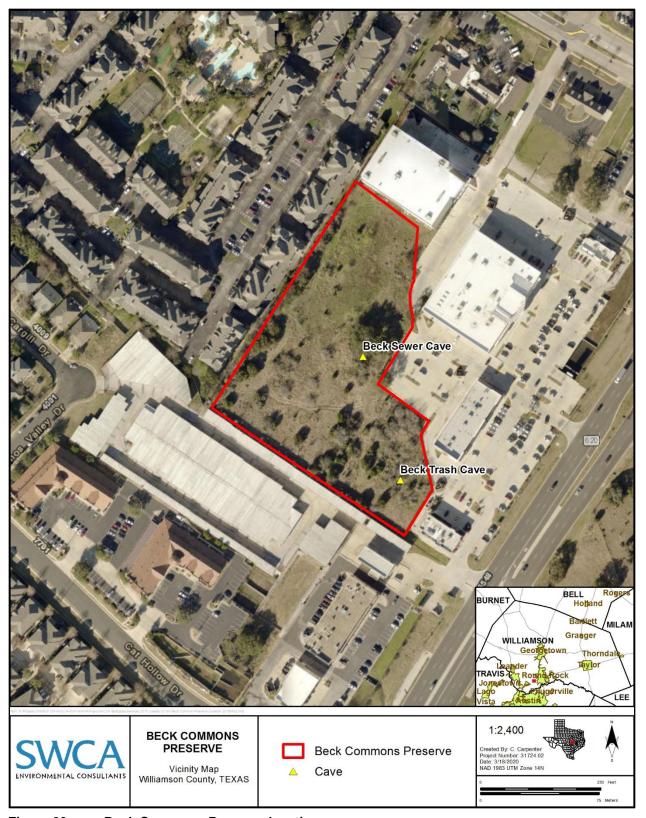
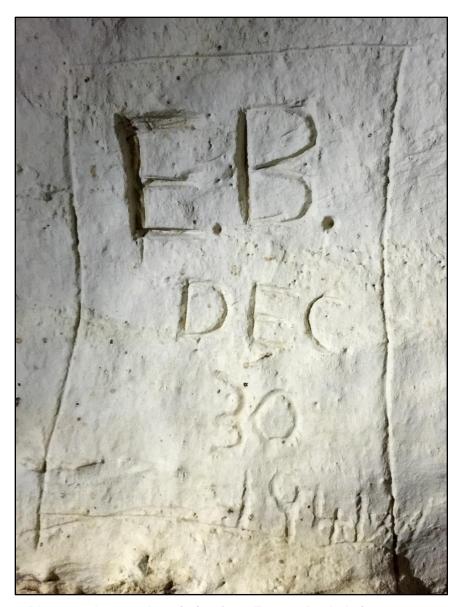


Figure 23. Beck Commons Preserve location map.



Photograph 33. Inscription from Eugene Beck dating to 1941.

## 2.12.2 Hydrogeology

The Beck Commons Preserve is located within the EARZ and Beck Sewer Cave is formed within the Edwards limestone. Cave extent, morphology, and fracture control indicates it is likely that the Beck Commons Preserve acts to provide recharge despite the surface catchment area not being well defined. Recharge may be suppressed in the northeast corner where fill material 1 to 2 feet deep has been deposited. Beck Sewer Cave allows access to lower levels, with clearly phreatic chambers that are relatively unaffected by the process of collapse and breakdown. The Beck Sewer Cave's lower level (Photograph 34) retains an underground stream appearance that has been drained of permanent flow by the aquifer's base level natural lowering. Active recharge can be observed within the cave most prominently in the lower levels.



Photograph 34. Beck Sewer Cave's lower level showing phreatic passage (white limestone) adjacent to reformed limestone (brown) cave wall.

### 2.12.3 Caves of the Beck Commons Preserve

Cave maps are included within Appendix L.

Several early cave descriptions on the Beck Commons Preserve had the wrong cave map associated with Beck Sewer Cave and the wrong cave name associated with Beck Trash Cave. The map for nearby Beck Ranch Cave (a cave outside the Beck Commons Preserve) had been associated with Beck Sewer Cave and the name "Beck Tin Can Cave" had been applied to Beck Trash Cave. Both sources of confusion were corrected with a renewed mapping effort in 2010.

Beck Sewer Cave and Beck Trash Cave are mapped as a single, very large cave. The entrance to Beck Sewer Cave is approximately 20 feet long and opens up into a large (~100 foot long) chamber that narrows to a muddy hallway, which then opens up to reveal a long (~50 long) travertine wall. This portion of Beck Sewer Cave includes large speleothems, pools of water with aquatic life, and ultimately a narrow constriction that is mapped to connect with Beck Trash Cave (Appendix L). Additionally, an unmapped portion of the Beck Sewer Cave is attached to the north side of the large room (called the Ren & Stimpy Room on the cave map, Appendix L) near the entrance. An approximately 10-foot drop reveals a maze a low crawlspaces that likely doubles the size of the mapped cave. The back of the unmapped cave is characterized by chalky limestone within conduits likely formed under phreatic conditions.

Beck Trash Cave is within the Beck Commons Preserve but will not be surveyed for endangered karst biota due to its dry atmospheric conditions and relative insignificance compared to Beck Sewer Cave. These features are linked and the Bone Cave harvestmen is known from both caves.

Table 24 shows documented species within the Beck Commons Preserve.

Table 24. Species Documented from the Beck Commons Preserve

	Species	Beck Sewer
	Permitted Species	
Texella reyesi		√
	Other Species	
Cristoto	Ceuthophilus cunicularis	√
Crickets	Ceuthophilus secretus	V
	Anapistula sp.	V
	Cicurina browni	√
	Cicurina varians	√
	Araneae	√
Avaabuida	Mygalomorph (Tarantula)	√
Arachnids	Cryptachaea porteri	√
	Tayshaneta sp.	√
	Pholcidae	√
	Tick	√
	Pseudoscorpion	√
	Speodesmus bicornourus	√
Milling deal Continuedos	Cambala speobia	√
Millipedes/ Centipedes	Lithobiomorpha	√
	Scutigeridae	√
	Rhadine subterranea	√
Beetles	Tachyini sp.	$\checkmark$
beeties	Batrisodes uncicornis	$\checkmark$
	Staphylinidae	V
	White Planarian	√
Aquation	Copepod	√
Aquatics	Bloodworm	√
	Ostracod	√
Mammala	Myotis velifer	$\checkmark$
Mammals	Perimyotis subflavus	√
	Eleutherodactylus marnockii	$\checkmark$
	Isopod	√
	Collembola	$\checkmark$
	Dipluran	$\checkmark$
	Tominotus sp.	√
Other Species	Surface Snail	√
	Helicodiscus sp.	√
	Assassin Bug	√
	Fly	√
	Gnat	√
	Black Ant	√

## 2.13 Shaman Cave Karst Fauna Area

### 2.13.1 Introduction

The Shaman Cave KFA is located north from Shell Road between Williams Drive (FM 2338) and SH 195 near the City of Georgetown (Table 25, Figure 24). Most of the 81.7-acre Shaman Cave KFA was originally set aside for karst conservation under the take avoidance plan developed by the Sun City Georgetown developers in 1994. The Bone Cave harvestman is documented from both Shaman and Powwow Caves, while *B. cryptotexanus* is documented from Shaman Cave. However, the distribution of six smaller caves within the Shaman Cave KFA indicates extensive mesocavern habitat presence between and around the large caves. Other local endemic cave fauna documented from the Shaman Cave KFA include *Cicurina vibora*, *Speodesmus bicornourus*, and *Rhadine noctivaga*, all are additional species addressed in the RHCP (SWCA et al. 2008).

The flora and fauna have begun a successional transition from overgrazed, managed grassland to a predominantly native woodland/grassland mosaic providing suitable habitat for native invertebrates, reptiles and amphibians, and bird species with the cessation of ranching activities more than 20 years ago. The Shaman Cave KFA occurs within the GCWA range and woodland may become suitable for GCWAs over time.

Table 25. Basic Information for the Shaman Cave KFA

Shaman Cave KFA Information	
Preserve Inception Year	2016
Acreage	81.7
Fence Status	None
Sign Status	None
Baseline Vegetation Survey Date	None
Owner	WCCF- Final land acquisition still underway as of December 31, 2020
Gated Caves	Powwow, Shaman
Non-gated Caves	Borgarigmie Pit, Florence No. 18, Haft Shaft, Hatchet, Shawntee Pit, Squaw

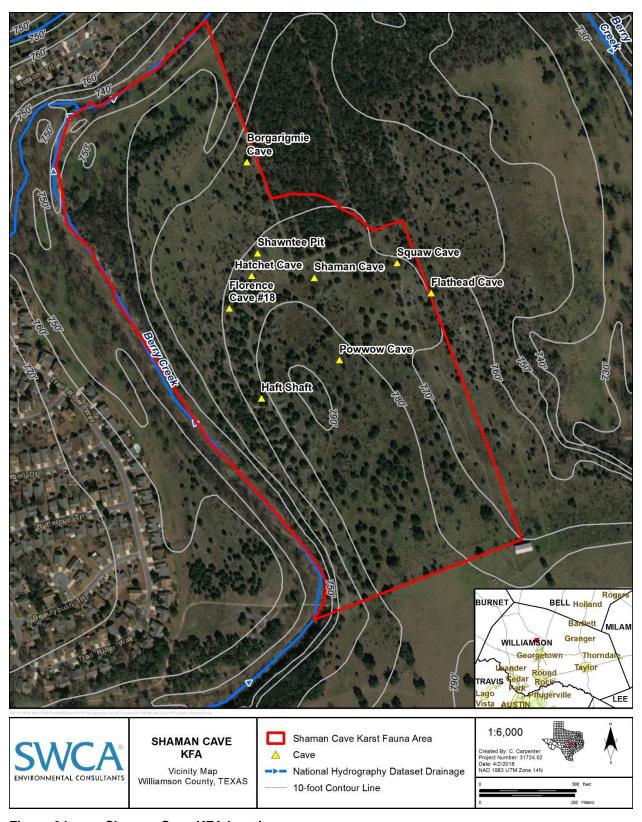


Figure 24. Shaman Cave KFA location map.

## 2.13.2 Hydrogeology

The Shaman Cave KFA occurs primarily on a broad, flat upland drained primarily to the west, north, and east by a distinctive bend in Berry Creek. Total relief across Shaman Cave KFA is approximately 50 feet ranging from 740 to 790 feet amsl. The Shaman Cave KFA is entirely underlain by the Edwards Limestone. The species-occupied caves occur primarily within the upper 20 feet of the hilltop and most cave entrances are formed between 770 and 780 feet amsl. Most traversable cave passage occurs between 760 and 770 feet amsl (Collins 2005; Senger et al. 1990) (Figure 25). This distribution suggests the presence of a highly developed, stratigraphically controlled cavernous zone of at least 25 acres, which likely extends somewhat continuously beneath the hilltop. This karstic horizon within the bedrock likely provides mesocavern habitat between the two endangered species-occupied caves and likely beyond.

No mapped faults occur within the Shaman Cave KFA, although fractures related to regional faulting are expressed within all caves. A mapped fault passes approximately 0.5-mile northwest of the Shaman Cave KFA (Collins 2005).

All caves within the Shaman Cave KFA have relatively limited surface drainage areas due to their upland terrain location. The endangered species-occupied caves all draw their surface runoff from the hilltop described above. Therefore, all surface runoff reaching the cave entrances and footprints originates from within the Shaman Cave KFA.

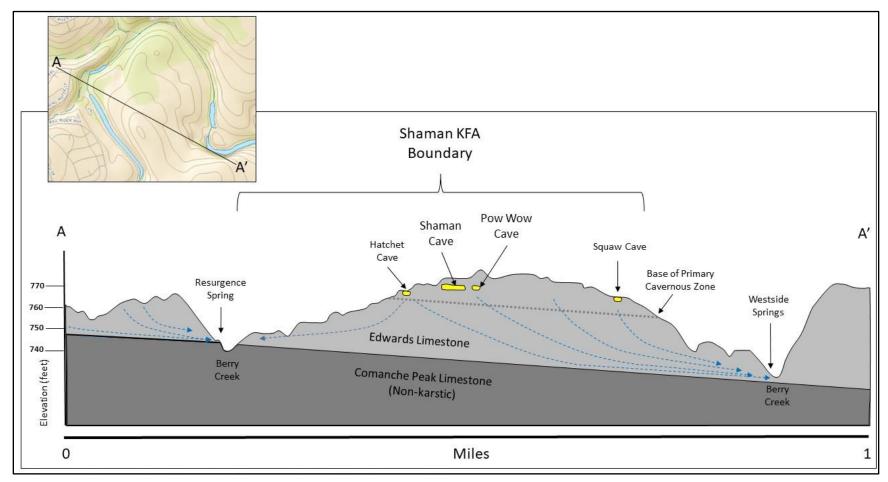


Figure 25. Geologic cross section of the Shaman Cave KFA.

### 2.13.3 Caves of the Shaman Cave Karst Fauna Area

The Shaman Cave KFA contains eight caves with two caves known to contain endangered karst invertebrate species, along with at least six "additional species" addressed in the RHCP (SWCA et al. 2008). Only Shaman and Powwow Caves are monitored for karst invertebrates. Appendix M includes cave maps for this KFA.

Shaman Cave: Shaman Cave is by far the largest and most biologically diverse cave within the KFA. It has a single passage trending northwest to southeast for approximately 240 feet. The cave is relatively flat in orientation and shallow with the passage majority formed between 5 and 10 feet below the surface. The entrance to Shaman Cave consists of a 1.5-foot-diameter opening in the bedrock, which drops approximately 5 feet to the top of a debris cone located in the middle of the cave's main passage. The main passage varies from 1.5 to 5 feet high and its width varies from 15 to 25 feet. The cave is approximately 237 feet long and reaches a maximum depth of 14 feet below the surface. Overall, the cave footprint takes the form of a slightly sinuous groundwater conduit with a northwest/southeast trend. Large floor drains accessible to humans at Shaman Cave's rear indicate connections to a deeper habitat zone. Shaman Cave is gated (Photograph 35) and interior conditions can be quite spacious (Photograph 36). The Bone Cave harvestman and the Dragonfly Cave mold beetle are both known from this cave.



Photograph 35. Biota survey crew preparing to enter Shaman Cave.



Photograph 36. Biota survey crew looking for karst invertebrates within Shaman Cave.

**Powwow Cave:** Powwow Cave is the second largest cave within the Shaman Cave KFA, with a footprint approximately 80 feet long by 30 feet wide. It is essentially a single breakdown chamber occurring between 5 and 15 feet below the surface. The overall cave morphology trends along northwest/southeast in a similar manner to Shaman Cave. The cave contains active speleothems including cave coral, stalactites and stalagmites. The entrance of Powwow Cave is gated (Photograph 37) and occurs in a depression measuring approximately 10 feet long by 4 feet wide. The Bone Cave harvestman is known from this cave.



Photograph 37. Entrance to Powwow Cave.

#### **Additional Caves**

The Shaman Cave KFA includes six caves that are not known to contain endangered karst invertebrates. These features are relatively small and shallow for researchers; however, the collective karst feature distribution suggests that Shaman Cave KFA's core is an interconnected cavernous and mesocavernous habitat area spanning more than 25 acres beneath the previously described hilltop. The significant caves' geomorphology suggests they formed from the collapse of a larger underlying karst void network that was likely formed under phreatic conditions in response to paleo-aquifer karst hydrology as groundwater followed an east-northeasterly path toward the Edwards Aquifer's confined zone. The current cave floors now are largely formed from breakdown material that has collapsed from the original cave ceiling. The modern cave network has chaotic morphology relative to the paleo cave network because the collapse process is incomplete. A relatively continuous network of voids formed in response to dissolution by flowing groundwater and is now an extensive mesocavern network largely inaccessible to human but readily available to karst invertebrates.

**Borgarigmie Pit Cave:** The Borgarigmie Pit Cave entrance in an oval opening measuring approximately 3 by 3 feet at the base of a shallow depression. The entrance shaft drops 13 feet to a low room measuring approximately 15 feet long by 7 feet wide. The room is formed along a fracture trending north 85 degrees east. This cave is not gated and is not monitored.

**Florence No. 18 Cave:** An entrance to Florence No. 18 Cave, measuring approximately 3 feet wide by 4 feet long, drops approximately 8 feet to a slope leading down into an irregular chamber aligned with a southwest-trending fracture. This cave is not gated and is not monitored.

**Haft Shaft Cave:** The Haft Shaft Cave entrance measures approximately 1.5 feet wide by 2 feet long and drops approximately 13 feet into one end of a low bedding plane room, measuring approximately 12 feet long by 6 feet wide. This cave is not gated and is not monitored.

**Hatchet Cave:** The entrance to Hatchet Cave is 8 feet wide, with a 1-foot-high slope leading to a series of subsequent drops and slopes that reach 19 feet deep, exhibiting an approximately 38-foot passage. This cave is not gated and is not monitored.

**Shawntee Pit Cave:** The Shawntee Pit Cave is a 12.5-foot-deep pit formed along a north/south-oriented fracture that has been solution-enlarged along an 8-foot-long area. The shaft width is between 1 and 4 feet. A sloping passage extends for another 5 feet from the shaft base. This cave is not gated and is not monitored.

**Squaw Cave:** Squaw is a single bedding plane room measuring approximately 14 feet long and trending southeast. The cave is formed between 2 and 4 feet below the surface and likely resulted from the collapse of a deeper void. This cave is not gated and is not monitored.

Table 26 shows documented species within the Shaman Cave KFA.

Table 26. Species Documented from the Shaman Cave KFA

Species		Shaman	Powwow	Borgarigmie Pit	Florence No. 18	Haft Shaft	Hatchet	Shawntee Pit	Squaw Cave
Permitted Species									
Batrisodes cryptotexanus		V	V						
Texella reyesi		V	V						
Other Species									
Crickets	Ceuthophilus secretus		V	V	√	V			
	Ceuthophilus cunicularis	V	V						
Arachnids	Cicurina vibora	V	<b>√</b>		<b>√</b>				
	Cicurina varians	V	√		<b>√</b>		<b>√</b>		
	Anapistula sp.	V							
	Tayshaneta sp.	V	√						
	Cryptachaea porteri	V							
	Mite	V	<b>√</b>	√					
	Pseudoscorpion		<b>√</b>						
	Pseudouroctonus reddelli	V	V						
Millipedes/ Centipedes	Speodesmus bicornourus	V	V				√		
	Cambala speobia	V	<b>√</b>		<b>√</b>		<b>√</b>		
Beetles	Rhadine noctivaga	V	V						
	Batrisodes uncicornis		V		V				
	Staphylinidae		V						
	Anillinus sp.	V	V						
	Beetle larva	V							
Reptiles/ Amphibians	Crotalus atrox	<b>√</b>							
	Eleutherodactylus marnockii	√ ·							
Other	Isopod	V							
	Perimyotis subflavus	V							
	Helicodiscus sp.	√							
	Assassin Bug	√	√						
	Texoreddellia aquilonalis	√							
	Collembola	V	<b>√</b>		<b>√</b>		<b>√</b>		
	Mosquito	,	<b>√</b>		,		,		
	Gnat	V	· √						
	Red Ant	V	, √	<b>√</b>		V		<b>√</b>	√ V
	Pogonomyrmex barbatus	\ √	,	,				,	,
	Surface Snail	\ √	<b>√</b>						
	Moth	V	<b>√</b>						
	Bark Louse	<b>√</b>	,						
	Earthworm	V √	<b>√</b>						
	Lailiwoiiii	V	V						

# 2.14 Bat Well Cave Preserve

## 2.14.1 Introduction

Bat Well Cave Preserve (Table 27) is approximately 46.5 acres and represents one of the more significant caves in Williamson County due to the combination of hydrogeological and biological attributes it exhibits. As a well-preserved phreatic conduit, the cave is illustrative of the inner workings of the Edwards Aquifer. It is a classic example of an underground stream that remains partially active. Hydrologically, it represents a mixing zone where the interaction between groundwater, surface water from Berry Creek, and upland recharge from rain events can be observed in real time. Once home to a large bat colony, the cave is also biologically significant due to the presence of groundwater fauna, including at least two stygobitic invertebrates and the Georgetown salamander.

The name of the cave stemmed from the observation that it housed one of the larger bat colonies in Williamson County. The cave was mined for guano as early as 1909 and written descriptions of the cave go back to at least 1962 when the cave was first mapped by members of the Southwestern Speleological Society (Reddell and Finch 1963). Bat Well Cave is located beneath a dry upland tributary to Berry Creek (Figure 26). The entrance drops from the bed of the drainage channel (Photograph 38) into what is essentially a horizontal tunnel trending from the southwest to the northeast where it branches. Passages leading away from the entrance have been referred to as the West Tunnel and the East Tunnel. The cave is known to take great volumes of water when the surface channel overflows its banks and runs into the cave entrance. The underground stream runs independently of surface runoff from the cave entrance.

Table 27. Basic Information for the Bat Well Cave Preserve

Bat Well Cave Preserve Information		
Preserve Inception Year	2020	
Acreage	46.5	
Fence Status	None	
Sign Status	None	
Baseline Vegetation Survey Date	None	
Owner	WCCF	
Gated Caves	Bat Well, Berry Creek	
Non-gated Caves	None	

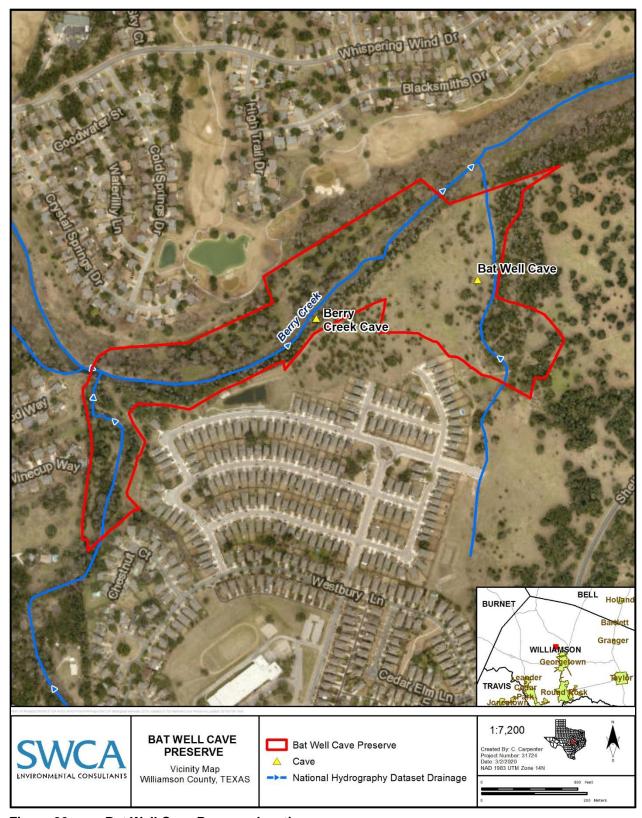


Figure 26. Bat Well Cave Preserve location map.



Photograph 38. View facing up, within Bat Well Cave's vertical shaft at the entrance that drops into the Edwards formation after penetrating the overlying Georgetown formation.

# 2.14.2 Hydrogeology

Bat Well Cave is formed within the lower half of the Edwards Limestone formation, which is approximately 110 feet thick in the Georgetown area (Figure 27). The cave evolved below the water table as a conduit for lateral flow of large volumes of water through the regional paleoaquifer. The cave stream currently flowing through the cave is a trickle compared with the flow capacity of the entire conduit. The rounded, tube-like interior of the main passage is indicative of formation under fully submerged conditions where slow-moving groundwater caused dissolution of the cave walls in all directions. The down-cutting of Berry Creek and other local waterways gradually dissected the aquifer outcrop, dropping the water table closer to the main passage. The cave likely went through a second period of enlargement as it began pirating base flow from Berry Creek. The destination of the stream passing through the cave is unconfirmed, but it likely feeds several springs that resurge in the bank of Berry Creek within the City of Georgetown's Westside Park located to the northeast. The modern cave entrance likely formed relatively recently in the cave's history when the floor of a surface gully intersected the upper level of the cave. Since then, the cave has acted as a highly efficient aquifer recharge feature. Depending on the aquifer conditions and rainfall, up to three forms of hydrology are acting on the cave at any given time. The cave stream is permanent groundwater flow, which is supplemented by the baseflow of Berry Creek. Fauna in the cave stream represent both stygobitic and surface freshwater species. Blind cave crustaceans are found alongside crayfish and minnows from Berry Creek. During heavy rains when the surface gully flows, large volumes of recharge enter the cave, bringing leaf litter and organic matter with it.

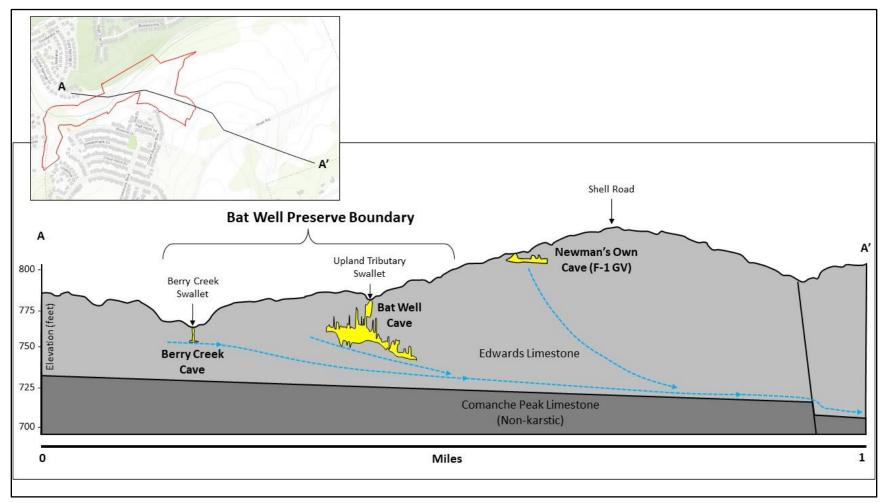


Figure 27. Geologic cross section of the Bat Well Cave Preserve.

### 2.14.3 Caves of the Bat Well Cave Preserve

The Bat Well Cave Preserve contains two mapped caves, both with subterranean stream passages. Bat Well Cave is the only feature documented to host *Eurycea* sp. No endangered karst invertebrates are known from either cave. Appendix N includes cave maps for this preserve.

Bat Well Cave: The cave entrance is formed in the south bank of a dry surface channel that drains approximately 200 acres after heavy rains. An approximately 10-foot-deep sinkhole connects the channel floor with a horizontal passage leading south into the cave. The cave is secured at this point with a vertical cave gate measuring approximately 10 feet wide by 4 feet high (Photograph 39). Approximately 20 feet beyond the gate, the horizontal passage leads to a vertical shaft measuring approximately 8 feet in diameter. The shaft drops approximately 25 feet into the main passage of the cave. The main passage extends in two directions from the bottom of the shaft formed along a prominent bedrock fracture trending from the northwest to the southeast (Photograph 40). The West Tunnel ranges from 15 to 20 feet high by 10 to 15 feet wide and extends for 345 feet before becoming plugged with soil. A small pool occurs on the south side of this passage and appears to connect with Berry Creek as catfish (Ictalurus sp.) have been seen in this pool. The tall but narrow East Tunnel runs approximately 121 feet before forking into the Upstream and Downstream Tunnels. The Upstream Tunnel extends at least 163 feet to a small stream that enters from the right wall, crosses the passage, and disappears down a hole (Photograph 41). Average ceiling height of the Upstream Tunnel is 7 feet. The Downstream Tunnel extends about 90 feet and intersects the same stream, which can be explored in both directions from this point. At about 20 feet downstream, a second stream intersects the first.

The West Tunnel was known to house one of the larger bat colonies in Williamson County in the 1960s. By August 1992, Bill Russel from the University of Texas reported that there was no evidence of guano, fresh or otherwise, although Russel attributed this to the flooding of the spring and summer and that bats were likely returning (Hunter and Russel 1992).



Photograph 39. Biota survey crew flipping rocks for invertebrates during 2020 survey.



Photograph 40. View of the vertical entrance shaft from lower level (from West Tunnel facing east).



Photograph 41. Downstream water passage located in the back of the upstream tunnel.

Early biological surveys of the Bat Well Cave were informal. Surveyors in 1962 and 1963 noted the presence of rattlesnakes, both on the main level and around the base of the entrance. Reddell and Finch (1963) indicate two collection trips were made to Bat Well Cave in 1963; the first by representatives of the Southwestern Speleological Society and the second by J. Reddell, R. Finch, and M. Lorfing. In a separate study, Lewis and Bowman (1996) described the subterranean Asellids in Williamson County as *Caecidotea reddelli*. In 1992, J. Hunter and B. Russel from the University of Texas collected genetic samples of the common cave amphipod, *Stygobromus* (syn. *Stygonectes*) *russelli*, which were discovered within the underground stream and were subsequently collected by Hunter (Hunter and Russel 1992). During one of these visits, Hunter and Russel (1992) explored the downstream passage to a syphon and collected an eyed, pigmented *Eurycea* salamander.

Berry Creek Cave: The cave entrance is a small portal formed in the bed of Berry Creek that peers into a subterranean stream passage flowing nearly perpendicularly to the overlying flow path of Berry Creek. The cave is a bell-shaped shaft approximately 12 feet down that extends approximately 16 feet wide at its base. A concrete riser is placed atop the cave entrance and holds in place a black metal gate (Photograph 42). WCCF installed a new cave gate in 2020. Berry Creek diverts significant flow into Berry Creek Cave when flowing water is present (Photograph 43). Berry Creek Cave's position within Berry Cave indicates this may be a significant local recharge point for the Edwards Aquifer and nearby springs in Sun City. The subterranean stream passage is of unknown depth and biota surveys have not occurred.



Photograph 42. Berry Creek Cave as seen when no water is present in Berry Creek.



Photograph 43. Berry Creek Cave as seen when water is present in Berry Creek and leaves are plugging the cave portal.

Table 28 shows documented species within Bat Well Cave.

Table 28. Species Documented from the Bat Well Cave Preserve

	Species	Bat Well Cave			
Permitted Species					
Texella reyesi		No			
Batrisodes cryptotexanus		No			
	Other Species				
Orialista	Ceuthophilus cunicularis	√			
Crickets	Ceuthophilus secretus	√			
	Eidmannella pallida	√			
	Cicurina vibora	√			
Annahutda	Leiobunum townsendi	√			
Arachnids	Cicurina varians	√			
	Meioneta sp.				
	Agyneta Ilanoensis	√			
	Oxidus gracilis	√			
	Cambala speobia	√			
Millipedes/ Centipedes	Speodesmus bicornourus				
	Lithobiomorpha	√			
	Geophilomorpha	√			
Partles	Batrisodes sp.	√			
Beetles	Staphylinidae	<b>√</b>			
	Ictalurus punctatus	√			
	Procambarus simulans	√			
Aquatics	Stygobromus sp.	√			
	Caecidotea sp.	V			
Mammals	Tadarida brasiliensis	√			
	Perimyotis subflavus	√			
	Procyon lotor	√			
	Eleutherodactylus marnockii	√			
	Craugastor augusti	√			
Reptiles/Amphibians	Crotalus atrox	√			
	Eurycea naufragia	V			
	Elaphe obsoleta lindheimeri	V			
Other Species	Collembola	V			
	Gastropoda	V			
	Arenivaga sp.	√			
	Earthworm	V			

# 2.15 Snowmelt Cave Preserve

#### 2.15.1 Introduction

The Snowmelt Cave Preserve was created in 2004 as part of the installation a raw water line transporting water over Snowmelt Cave. The Brushy Creek Municipal Utility District managed Snowmelt Cave Preserve until 2019. The WCCF acquired the Snowmelt Preserve in 2019 as mitigation for Williamson County widening CR 176 and stabilizing (filling) the underlying cave to ensure structural integrity. The WCCF plans to manage the 1.3-acre Snowmelt Cave Preserve in the same manner as for other preserves.

Snowmelt Cave (Table 29) was so named due to the presence of a rare snowfall in Central Texas, with warm morning sunshine causing runoff to enter the cave when it was mapped (Peter Sprouse, personal communication, June 29, 2018). The humanly accessible extent is mapped as approximately 120 feet long, up to 36 feet wide, and up to 12 feet deep. Approximately half of the eastern cave extent is mapped within the Snowmelt Cave Preserve, while the remainder is underneath CR 176 and below an adjacent tract across the road from the preserve (Figure 28). Road widening triggered Williamson County to fill the cave extent below CR 176 for safety reasons, due to the shallow nature of the Snowmelt Cave. However, the eastern extent remains within the Snowmelt Cave Preserve and is in a relatively natural state.

The land around the cave entrance is privately owned and the preserve easement for Snowmelt Cave was managed by Brushy Creek Municipal Utility District (BCMUD). Pine (2004) details the 1.3-acre Snowmelt Cave easement within a Biological Opinion that states "BCMUD will complete negotiations with the landowner and initiate operation of the preserve by December 31, 2004."

Appendix O includes a cave map showing the full extent, as mapped in 2002.

Table 29. Basic Information for the Snowmelt Cave Preserve

Snowmelt Cave Preserve Information		
Preserve Inception Year	2019	
Acreage	1.3	
Fence Status	None	
Sign Status	Warning sign on cave gate	
Baseline Vegetation Survey Date	None	
Owner	Easement (McLester Elmer TR and Karen Wunsch et al.)	
Gated Caves	Snowmelt Cave	
Non-gated Caves	None	

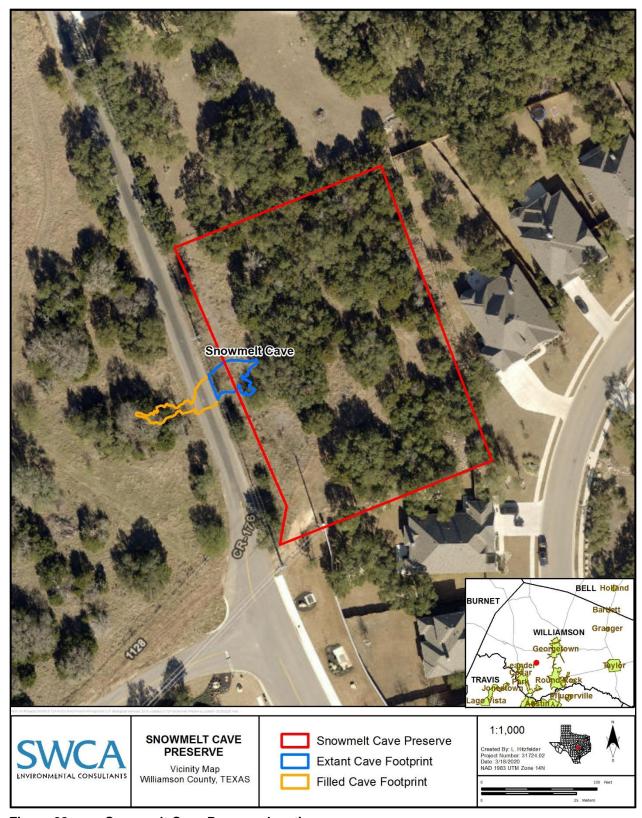


Figure 28. Snowmelt Cave Preserve location map.

# 2.15.2 Hydrogeology

Snowmelt Cave Preserve occurs within the EARZ on the western edge of a topographic ridge that is the surface water drainage basin divide between Brushy Creek to the west and Chandler Branch to the east. The surface elevation is approximately 980 feet amsl. Because the cave is located in a gently sloping area near a ridge, the surface water catchment basin is not large.

The thickness of the Edwards Limestone is approximately 40 to 50 feet at the cave location based on mapping by Collins (2005) but thickens toward the east because the formation dips eastward. The contact between the Edwards Limestone and the underlying, less-permeable Comanche Peak is exposed at an elevation of approximately 950 feet, which occurs approximately 0.25 mile west of Snowmelt Cave Preserve. The formations dip toward the east and the Edwards and Comanche Peak contact is exposed at elevations of less than 800 feet along the southern bank of the South Fork San Gabriel River east-northeast of the preserve.

According to a Texas Water Development Board (TWDB) Well Schedule and Well Report for State Well No. 58-26-301, the depth to water just north of the Snowmelt Cave Preserve was measured at approximately 180 feet in 1971. A 180-foot water depth is stratigraphically lower within the Edwards Aquifer than the preserve area. The well report did not mention the presence of water at shallower depths. The exact direction of groundwater flow beneath the Project Area is unknown; however, groundwater could potentially become perched within the Edwards Aquifer on top of the Comanche Peak and flow northward to discharge at one or more of at least six springs located along the southern edge of the South Fork San Gabriel River. The South Fork San Gabriel River's closest point to the Snowmelt Cave Preserve is approximately 1.3 miles north. Alternatively, instead of traveling northward toward the South Fork San Gabriel River's springs, groundwater recharging in the area of the Snowmelt Cave Preserve may move more eastward in the regional direction of surface topography and in the direction the beds dip, although surface topography slopes westward toward Brushy Creek. Groundwater flow may also follow surface contours and flow southwest toward Brushy Creek to discharge along the contact between the Edwards Limestone and Comanche Peak. However, no springs are mapped along the eastern side of Brushy Creek near the Project Area.

The floor of the cave dips gently toward the east-northeast, which supports a north or eastward groundwater flow direction toward South Fork San Gabriel River or Chandler Branch. No formal hydrogeological study has been performed in Snowmelt Cave. Snowmelt Cave itself appears to have formed as a phreatic chamber from groundwater flowing from the southwest end of the cave toward the northeast end of the cave. The cave is now located above the groundwater table and only intercepts water recharging and moving downward through the vadose zone.

#### 2.15.3 Caves of the Snowmelt Cave Preserve

Cave maps are included within Appendix O.

**Snowmelt Cave:** The Snowmelt Cave map indicates the cave footprint extends underneath the existing CR 176 and continues west, beyond the road. Cave footprint dimensions (prior to stabilization efforts) are approximately 130 feet long and up to 12 feet deep, with the cave ceiling approximately 7 feet below the existing CR 176. However, all portions of the cave outside of the preserve have been filled to stabilize the CR 176 expansion (Photograph 44); therefore, Snowmelt Cave is likely closer to 80 feet long in its current state. The cave appears to have formed within the phreatic zone by groundwater moving slowly toward the east-northeast, because the current floor of the cave and bedding dips toward the east-northeast. Most of the cave is a crawlway with low ceiling that becomes lower in the up-dip direction toward the west-southwest. Snowmelt Cave is gated (Photograph 45). USFWS (2018a) indicates

Snowmelt Cave is a known Bone Cave harvestman locality. However, the species was not seen during biota surveys occurring 2013 and 2015 (ZARA 2017); nor was the species located by SWCA during 14 presence/absence surveys in 2019 (personal communication Stephen Van Kampen-Lewis). See Table 30 for summary all biota detected within Snowmelt Cave over time.

Table 30. Species Documented from the Snowmelt Cave Preserve

	Species	Snowmelt Cave			
Permitted Species					
Texella reyesi		√			
	Other Species				
Crickets	Ceuthophilus cunicularis	$\checkmark$			
Crickets	Ceuthophilus secretus	V			
	Eidmannella sp.	$\checkmark$			
	Araneae	$\checkmark$			
Augustustus	Cicurina vibora	$\checkmark$			
Arachnids	Anapistula sp.	$\checkmark$			
	Leiobunum townsendi	√			
	Cicurina varians	√			
	Cambala speobia	√			
Millipedes/ Centipedes	Scutigeridae	√			
	Speodesmus bicornourus	√			
	Lithobiomorpha	√			
Beetles	Batrisodes uncicornis	√			
	Elaphropus sp.	√			
	Staphylinidae	√			
Vertebrates	Procyon lotor	√			
	Incilius nebulifer	√			
Other Species	Collembola	√			
	Texoreddellia sp.	√			
	Helicodiscus sp.	√			
	Labidus coecus	√			
	Isopod	√			
	Diptera	√			
	Annelid	√			



Photograph 44. Sandbags within Snowmelt Cave that were installed as part of cave stabilization efforts.



Photograph 45. Snowmelt Cave entrance showing gate and surrounding vegetation.

# 2.16 Hidden Springs Ranch

## 2.16.1 Introduction

Hidden Springs Ranch is approximately 932.5 acres and lies mostly in Williamson County, but extends north into Burnet County, and is located approximately 4 miles northwest of the City of Florence, Williamson County (Figure 29). This property was primarily purchased for its GCWA habitat and has no known caves.

Hidden Springs Ranch lies within the Cross Timbers ecoregion and the Lampasas River watershed of the Brazos River basin. The ranch has frontage to the south on Williamson County Road 224. The southern third of the ranch lies on a broad, relatively flat top of a ridge formed from the Keys Valley Marl. Elevations on the ranch generally descend toward the north away from the top of this ridge. The central and northern portions of the ranch contain the headwaters of the McDaniel Branch of Mill Creek, with this creek running generally northward through the center of the ranch. Topography in the central and northern portions of the ranch is hilly, with rolling uplands incised by McDaniel Branch and many short tributaries that combine to form a dendritic pattern. Stream erosion has removed the Keys Valley Marl from these portions of the ranch to expose, in descending order, the underlying Cedar Park Limestone, Bee Cave Marl, and upper Glen Rose formations.

The Keys Valley Marl is a soft carbonate formation that degrades to form comparatively deep soils suitable for agricultural uses. For this reason, the broad ridgetop on which the southern portion of the ranch lies has been widely converted to pasture, both on and adjacent to Hidden Springs Ranch. Maintenance of these pastures on Hidden Springs Ranch appears to not have been performed in recent times, and these pastures are being invaded by shrubby Ashe juniper (*Juniperus ashei*) and mesquite (*Prosopis glandulosa*). This portion of the ranch does not contain woodland habitat suitable for use by GCWA.

In contrast to the southern portion of the ranch, geology in the central and northern portions of Hidden Springs Ranch consists mostly of hard limestones that form thin soils. Probably owing to a combination of thin soils and hilly topography, these portions of the ranch appear to have historically been used as rangeland and mostly without having been converted to pasture. The Soil Survey of Williamson County, Texas, which contains aerial photography circa 1980, indicates that approximately 40 years ago these portions of the ranch mostly contained open woodland with some nearly barren hillsides, none of which would have provided habitat for GCWA. Based on current conditions as discussed below, it appears possible that over the past 40 years, vegetation in the central and northern portions of Hidden Springs Ranch has been allowed to naturally succeed into a more wooded state (Photographs 46–48).

McDaniel Branch is contained within a long, branched canyon. The floor of this canyon now mostly supports closed or nearly closed woodland composed primarily of Ashe juniper and plateau live oak trees, although along and near the creek channel the woodland also contains cedar elm (*Ulmus crassifolia*), American sycamore (*Platanus occidentalis*), and Arizona black walnut (*Juglans major*) trees, some of the walnut trees are in excess of 40 feet tall. Across the floor of the canyon, the Ashe juniper and live oak trees in this woodland are mostly 16 to 30 feet tall. This closed or nearly closed woodland provides habitat suitable for use by GCWA.

One relatively large pasture is present on the floor of the canyon that contains the McDaniel Branch, mostly in Burnet County and on the east side of the creek channel. This pasture is rather long and narrow and is crossed by a set of low berms, presumably built to control erosion historically. This pasture mostly contains grasses and forbs, but is being invaded by some shrubby Ashe juniper, particularly along its eastern edge. This pasture does not provide habitat for GCWA.

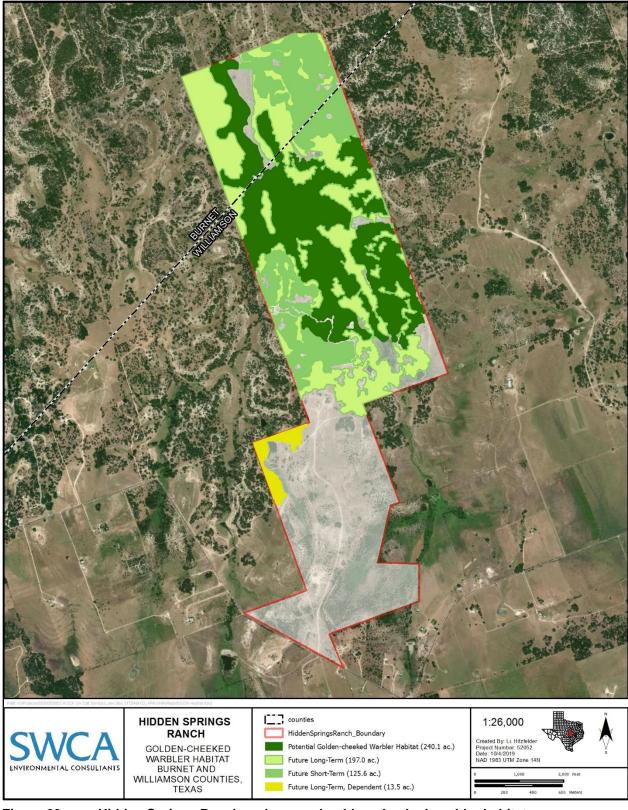


Figure 29. Hidden Springs Ranch and mapped golden-cheeked warbler habitat.

The dendritic pattern of drainages in the central and northern portions of the ranch have created a fingered series of ridges that confine the drainage system. These ridges have something of a stair-step topography, with steeper slopes in some places separated by relatively flat benches. The steeper slopes largely support open, scrubby Ashe juniper woodland, with most trees ranging from 6 to 18 feet tall. These slopes are formed of hard limestone that likely promotes surface water runoff rather than water retention, resulting in comparatively xeric conditions that do not favor growth of oak or other hardwood trees and appear to stunt the growth of the Ashe juniper. These open scrubby woodlands do not currently provide habitat suitable for GCWA. The topographic benches support stands of semi-open to relatively dense Ashe juniper/live oak woodland with very low densities of Texas oak (Quercus buckleyi) trees. Some of these stands of woodland have a nearly closed canopy and are essentially contiguous with the closed/nearly closed woodland developed in the canyon that contains McDaniel Branch. These stands may provide habitat suitable for use by GCWA. Other stands occur at greater distance from the canyon and have a more open canopy. These stands of woodland, if allowed to continue to succeed naturally, can be expected to gain suitability as GCWA habitat. A few of the topographic benches support open grassy clearings, perhaps a result of past land management activities performed to support livestock grazing. These clearings do not constitute GCWA habitat.

#### 2.16.2 Golden-cheeked Warbler Habitat

Figure 29 depicts the distribution of woodland on Hidden Springs Ranch that appeared suitable for use by GCWA during a habitat evaluation that occurred in 2019. At that time, approximately 240.1 acres of woodland present on the ranch appeared suitable for use by the GCWA. Based on the configuration and extent of this woodland, it was assumed highly probable that GCWA occur as breeding season residents of Hidden Springs Ranch.

Figure 29 also depicts the distribution of woodland on Hidden Springs Ranch that with time could gain suitability for use by the GCWA. These woodlands were divided into three categories: Future Short Term (125.6 acres); Future Long Term (197.0 acres); and Future Long Term, Dependent (13.5 acres). As seen on Figure 29, most of the central and northern portions of Hidden Springs Ranch were identified as containing potentially suitable GCWA habitat or having potential to support GCWA habitat with time.

#### 2021 Golden-cheeked Warbler Survey Results

The field survey results from 2022, similar to the results of the 2021 survey, again indicated that GCWA utilize the woodlands of Hidden Springs Ranch more widely than suggested by the SWCA 2019 habitat delineation. The results of the acoustic monitoring also support the previous findings that golden-cheeked warblers occur more widely throughout the woodlands of Hidden Springs Ranch than initially anticipated from the 2019 habitat delineation.

Based on the results of the 2022 survey, SWCA again updated the delineation of golden-cheeked warbler habitat on Hidden Springs Ranch. The delineation was updated to 1) add in some woodlands where SWCA detected golden-cheeked warblers in 2022 where none had been detected during the 2021 survey; 2) add in woodland that is similar in appearance to and contiguous with the woodland added because warblers were newly detected in it; and 3) to eliminate some small pockets of more open woodland surrounded by stands of more closed woodlands previously delineated as golden-cheeked warbler habitat. As a result of these revisions, a total of approximately 459.5 acres of golden-cheeked warbler habitat is identified as present on Hidden Springs Ranch. Figure 30 depicts this revised habitat delineation and the results of the 2021 and the 2022 GCWA surveys.

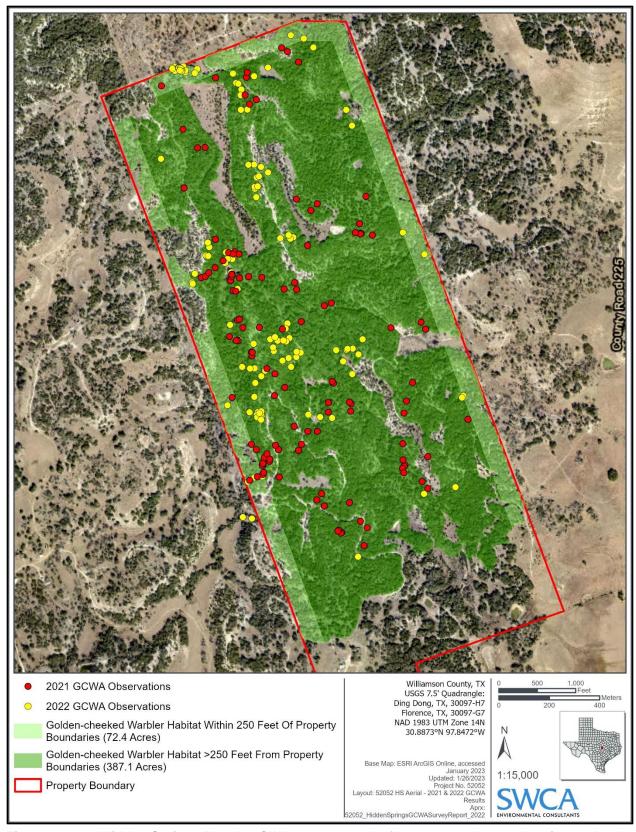


Figure 30. Hidden Springs Ranch GCWA survey results from 2021 and 2022 showing updated habitat delineation.



Photograph 46. Scrubby juniper forest on a hill side at Hidden Springs Preserve.



Photograph 47. Treeless portion of savannah mosaic at Hidden Springs Preserve.



Photograph 48. Forested lowland at Hidden Springs Preserve.

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